Revival of Traditional surface water conservation system in Kishangarh, Rajasthan

Project Phase -II Report submitted to
Visvesvaraya National Institute of Technology, Nagpur
in partial fulfillment of the requirements for the award of the degree

Master of Technology
In
Urban Planning

by

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Under the guidance of

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2024-25

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I, **Priyanshi Gupta,** hereby declare that this project titled "**Revival of Traditional surface water conservation system in Kishangarh, Rajasthan"** is carried out by me in the **Department of Architecture and Planning** of Visvesvaraya National Institute of Technology, Nagpur. The work is original and has not been submitted earlier whole or in part for the award of any degree/diploma at this or any other Institution / University.

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Date:

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This to certify that the project titled **"Revival of Traditional surface water conservation system in Kishangarh, Rajasthan"** is submitted by **Priyanshi Gupta** in partial fulfilment of the requirements for the award of the degree of **Master of Technology in Urban Planning**, VNIT Nagpur. The work is comprehensive, complete and fit for final evaluation.

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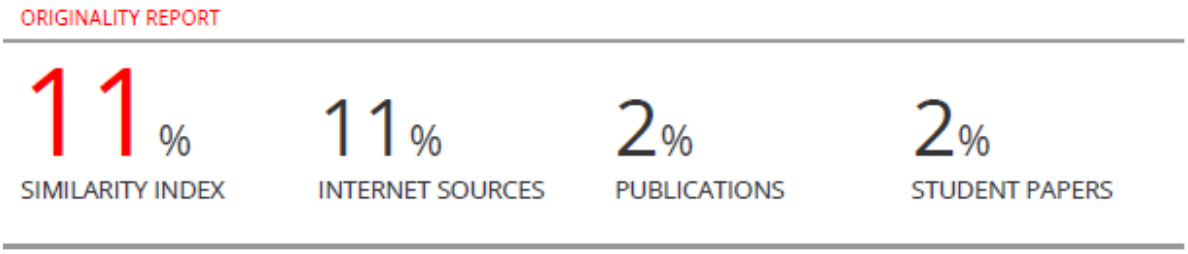

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ABSTRACT

Kishangarh, a historically significant town in Rajasthan, has long relied on its traditional surface water conservation systems to sustain life in a semi-arid environment. The city's water management heritage is rooted in an intricate network of interconnected lakes, canals, and reservoirs—such as **Gundolav Talav**, **Hameer Sagar**, **Ransamand**, and **Satolav Talav**—many of which were developed as early as the 15th century. These systems not only supported drinking water and irrigation needs but also played a vital role in flood management and groundwater recharge, making them a resilient model of decentralized water infrastructure.

However, with rapid urbanization, unregulated industrial expansion, and inadequate planning interventions, these traditional water bodies have witnessed severe degradation. Issues such as encroachment, pollution from marble processing industries, solid waste dumping, and loss of natural drainage channels have diminished the ecological and functional value of these assets. The decline of this once self-sustaining water system has led to increasing dependence on distant sources like the **Bisalpur Dam**, raising concerns about long-term water security.

This study aims to analyze the historical significance, present condition, and challenges faced by Kishangarh's traditional surface water systems. Through spatial mapping, land use analysis, and review of urban planning documents, the research identifies critical pressure zones and highlights planning lapses that have contributed to the disconnection of these natural systems. The study advocates for the **revival and integration of traditional water infrastructure** within the modern urban planning framework. It recommends the creation of protective buffer zones, restoration of canal networks, decentralized wastewater treatment, and community participation as key strategies to rejuvenate these systems.

Reviving Kishangarh's traditional water structures is not only a matter of environmental necessity but also of cultural preservation. Such efforts would enhance the city's resilience to climate variability, promote sustainable water management, and re-establish the historic relationship between the people and their water bodies—setting an example for other towns facing similar hydrological and urban challenges.

Keywords; Traditional water systems, Surface water conservation, Kishangarh, Gundolav Talav, Water security

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Chapter -1

Introduction

1.1 Background

Water scarcity is an escalating global crisis, particularly in regions with erratic rainfall patterns. Increasing population, unregulated urbanization, and pollution have exacerbated this issue. According to the World Resources Institute, 54% of India faces high to extremely high-water stress, and 54% of India's groundwater wells are also declining.

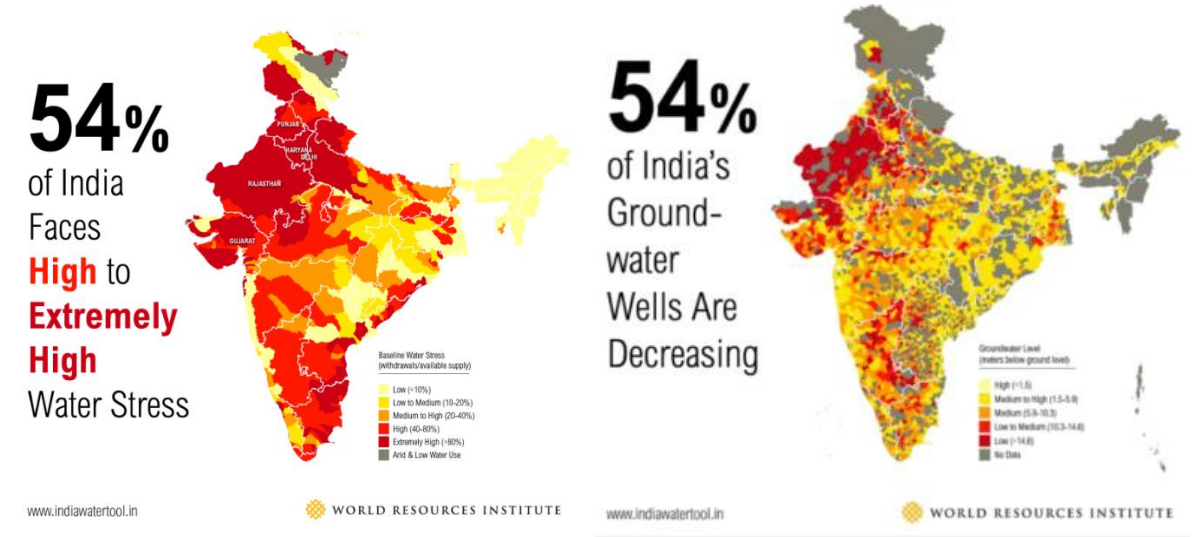

Figure 1 Images showing water stress in India

India ranks 141st in per capita freshwater availability, with an annual per capita water availability of 1486 cubic meters, as per the Water Related Statistics-2021 published by the Central Water Commission, Government of India. This data classifies India as a water-stressed country. (Urban Water Security Toolkit , 2017)

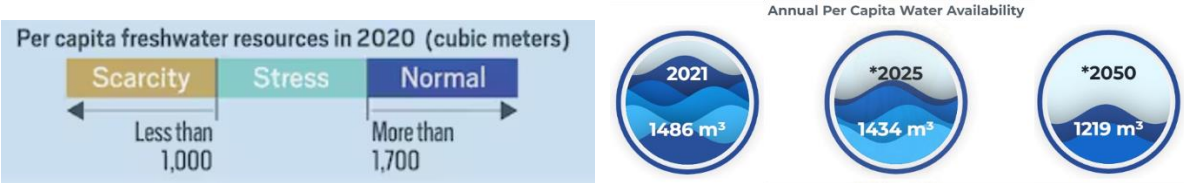

Figure 2 Meter showing Scarcity, Stress and normal level of per capita water availability and annual per capita water availability of India

Due to water scarcity, people are forced to rely on sources like surface water, unprotected and potentially contaminated wells, or vendors selling water of uncertain origin and quality. History teaches us that many civilizations have perished due to water scarcity. Over the years, cities and villages have become increasingly dependent on water sources located far away.

In the past, cities and towns, even in harsh climates like the Thar Desert, survived through traditional water conservation methods. However, with the advent of modern piped water supply, these practices were neglected, leading to the decline of interlinked catchment systems and lakes. This has contributed to the current water scarcity, especially in rural areas where centralized water supply systems are often expensive and inaccessible.

Reinvigorating traditional water conservation techniques may provide a sustainable solution to address water security, as they have proven effective throughout history.

1.2 Need of the study

Water is a critical natural resource. Globally, 2.1 billion people lack access to safely managed drinking water services, and 700 million people could be displaced by intense water scarcity by 2030.

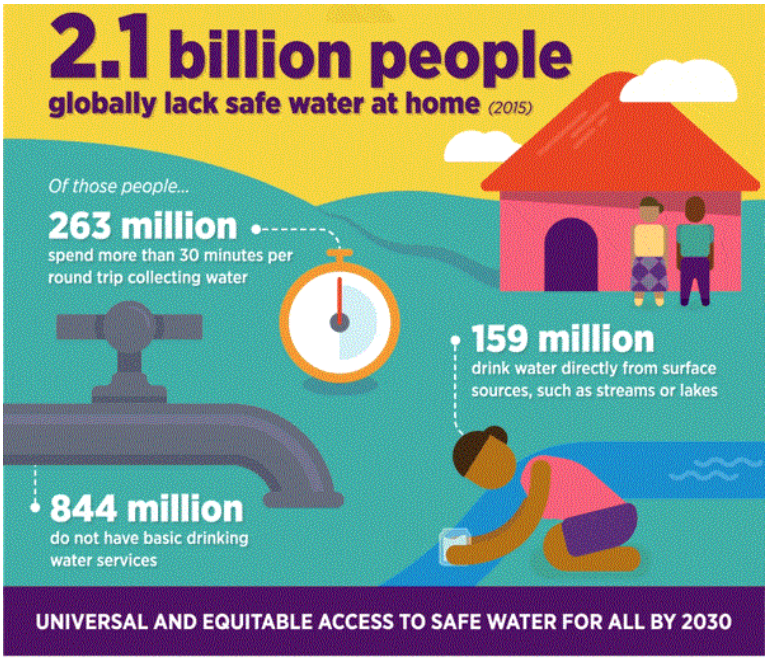
2.1 billion people
globally lack safe water at home (2015)
Of those people...
263 million
spend more than 30 minutes per round trip collecting water
159 million
drink water directly from surface sources, such as streams or lakes
844 million
do not have basic drinking water services
UNIVERSAL AND EQUITABLE ACCESS TO SAFE WATER FOR ALL BY 2030
World Health Organization
unicef

Figure 3 Global lack of safe water

The global community has also recognized the importance of this issue in the "2030 Agenda for Sustainable Development," specifically in the Sustainable Development Goals (SDGs) on water. The goal is to ensure the availability and sustainable management of water and sanitation for all. Target 6.4 states that by 2030, we must substantially increase water-use efficiency across all sectors and ensure sustainable withdrawals and supply of freshwater to address water scarcity and reduce the number of people suffering from it.

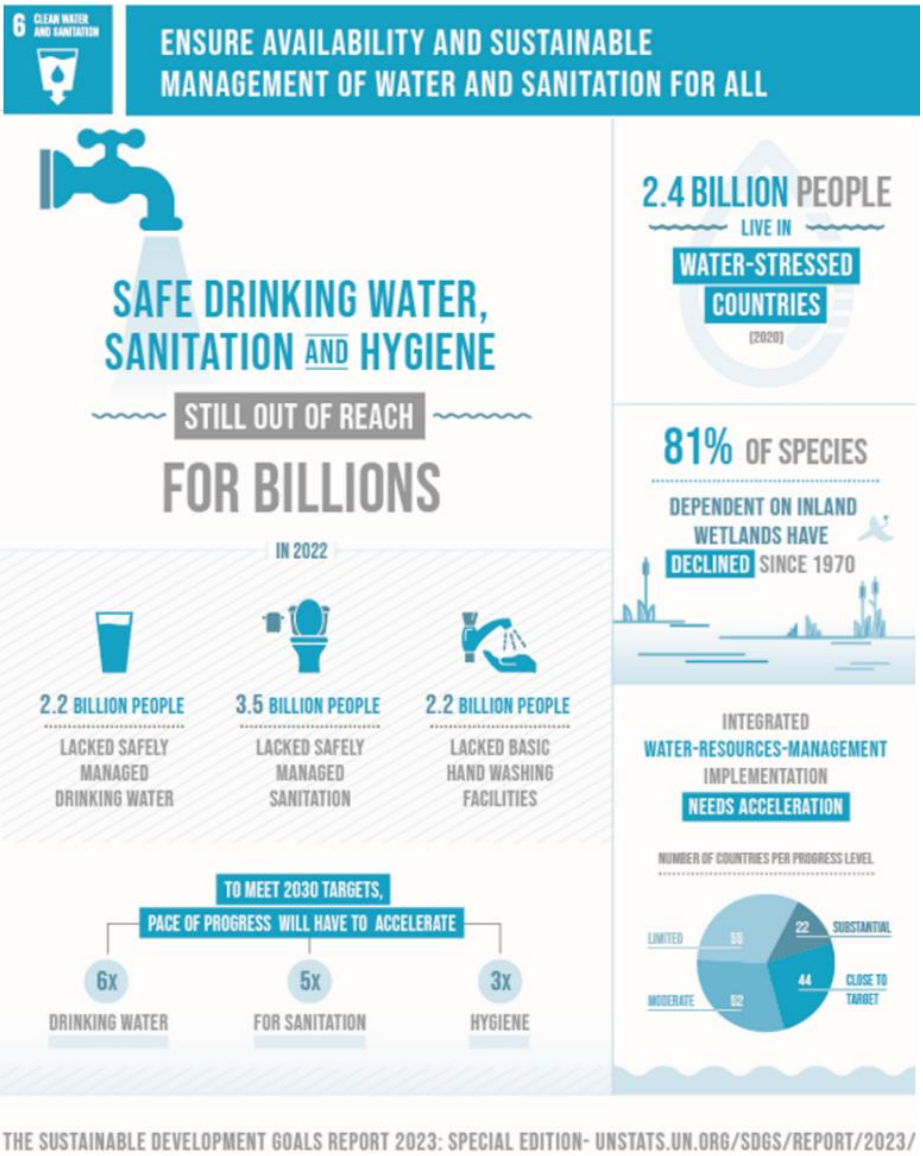

Figure 4 Sustainable Development Goal 6

Water is an essential component of human ecology. It is deeply rooted in many cultures, especially in Indian traditions, where it is considered a sacred element. According to ancient

Hindu beliefs, water is one of the five elements of the cosmic world. It is worshipped, and the sources of rivers are revered as holy places.

1.3 How we can reduce water scarcity?

To address the growing water scarcity crisis, a combination of nature-based solutions and technological interventions is essential. Nature-based solutions, such as protecting natural water bodies and reforestation, can strengthen natural processes and enhance water conservation. Additionally, man-made interventions, like rainwater harvesting and efficient irrigation systems, can complement these natural processes. India, with its rich history of water management, offers valuable insights. Traditional practices like constructing stepwells, khadins, and johads demonstrate the ingenuity of our ancestors in harnessing and conserving water. By reviving and integrating these traditional techniques with modern technology, we can develop sustainable water management strategies that ensure a water-secure future for generations to come. (Wipperman, 2020)

Figure 5:Chaand Baoli, the largest step well in India in Abhaneri, Rajasthan.

1.4 History of Water Conservation

India's water conservation history reflects the ingenuity of our ancestors who integrated water management into daily life. This wisdom ensured water availability for all and fueled development. Reviving and adapting these practices can help address contemporary water challenges, especially in rural areas.

India has a rich and long history of water conservation practices dating back to the Indus **Valley Civilization (3300-1300 BCE). Here's a glimpse into this legacy:**

India's water management heritage dates back to the **Indus Valley Civilization (3300–1500 BCE)**, where archaeological findings from cities like **Dholavira**, **Mohenjo-Daro**, and **Harappa** reveal the existence of sophisticated urban water systems, including **brick-lined wells**, **reservoirs**, and **drainage channels**. Dholavira, in particular, had several rainwater harvesting reservoirs showcasing early efforts in managing seasonal water availability.

During the **Mauryan Empire (322–185 BCE)**, water infrastructure became more regulated and strategic. Kautilya's *Arthashastra* documented the construction of **dams**, **bunds**, and strict water management regulations. Taxes on cultivators were adjusted based on whether their fields were irrigated using natural sources or man-made systems.

Between the **1st century BCE and 15th century AD**, numerous dynasties contributed to the expansion of water infrastructure across India. The **Satavahanas** introduced **brick and ring wells**, while the **Pandyas**, **Cholas**, and **Chera** rulers of South India developed extensive lake and well irrigation systems. The **Gupta Empire (300–500 AD)** focused on large-scale water resource development, and the **Pallavas** expanded irrigation networks, including the construction of the famed **Cauvery anicut**.

The **Cholas (985–1205 AD)** advanced water management with the development of **anicuts**, **chain tanks**, and intricate canal systems. In North India, the **Rajputs** promoted irrigation works, including the creation of the massive **Bhopal Lake** (647 sq. km). **Eastern Indian** dynasties like the **Palas** and **Senas (760–1100 AD)** constructed large tanks and lakes, while **Medieval rulers** such as **Mohammad Bin Tughlaq** and **Feroze Shah Tughlaq** encouraged the construction of rainwater harvesting systems and public wells.

The **Mughal period** also saw significant developments, with **Emperor Shah Jahan** constructing prominent canals like the **Bari Doab Canal**. In southern India, the **Vijayanagara**

Kingdom (1336–1546 AD) built numerous storage tanks, such as the **Anantraj Sagar tank**, supported by a 1.37 km-long dam. The **Bahamani rulers** introduced **canal irrigation** in the eastern Deccan region for the first time, further enhancing agricultural productivity and water access.

This long legacy demonstrates how traditional water systems across India were adapted to regional geography and supported community resilience—insights that remain relevant for modern water management challenges. (Meghalaya, 2022)

Period	Civilization/Dynasty	Key Water Conservation Practices
3300-1300 BCE	Indus Valley Civilization	Brick-lined wells, rainwater harvesting reservoirs
322-185 BCE	Mauryan Empire	Dams, bunds, regulated water supply systems
1st Century BCE - 2nd Century AD	Satvahanas	Brick and ring wells
1st-3rd Century AD	Pandyas, Cholas, Cheras	Lake and well irrigation, large water structures
300-500 AD	Gupta Empire	Large-scale water resource development
7th Century AD	Pallavas	Expansion of irrigation systems, Cauvery anicut
985-1205 AD	Cholas	Advanced irrigation systems, anicuts, chain tanks
1000-1200 AD	Rajput Dynasty	Irrigation works, large lakes (e.g., Bhopal Lake)
760-1100 AD	Palas and Senas	Construction of large tanks and lakes
Medieval Period	Various Dynasties (Delhi Sultanate, Mughal Empire, Vijayanagara Empire)	Rainwater harvesting systems, wells, canals, and large tanks

Table 1 History of Water Conservation

Figure 6 Images from Mohanjodaro

1.5 Aim

To assess the potential of reviving traditional water conservation techniques in enhancing water security Kishangarh, Rajasthan.

1.6 Objectives

1. **To study t**he traditional water conservation techniques/ methods of the selected area of Rajasthan.
2. **To understand** the social and cultural significance of these techniques – how they are integrated into community practices and beliefs.
3. **To study** the policies related to traditional water conservation technique in the selected area.
4. **To assess** the applicability of these traditional techniques in the selected area.
5. **To develop** a water conservation plan with respect to traditional water conservation techniques.

1.7 Scope

The study will concentrate on tier-3 and tier-4 cities, near the big cities in Rajasthan, the driest state of India and a region with a rich history of traditional water conservation practices.

1.8 Limitations

- The study will not address the cost of implementing these traditional water

conservation methods.

- This study does not aim to replace conventional water systems. Instead, it seeks to provide insights and solutions for areas where existing systems are insufficient or unable to meet community needs.

1.9 Methodology

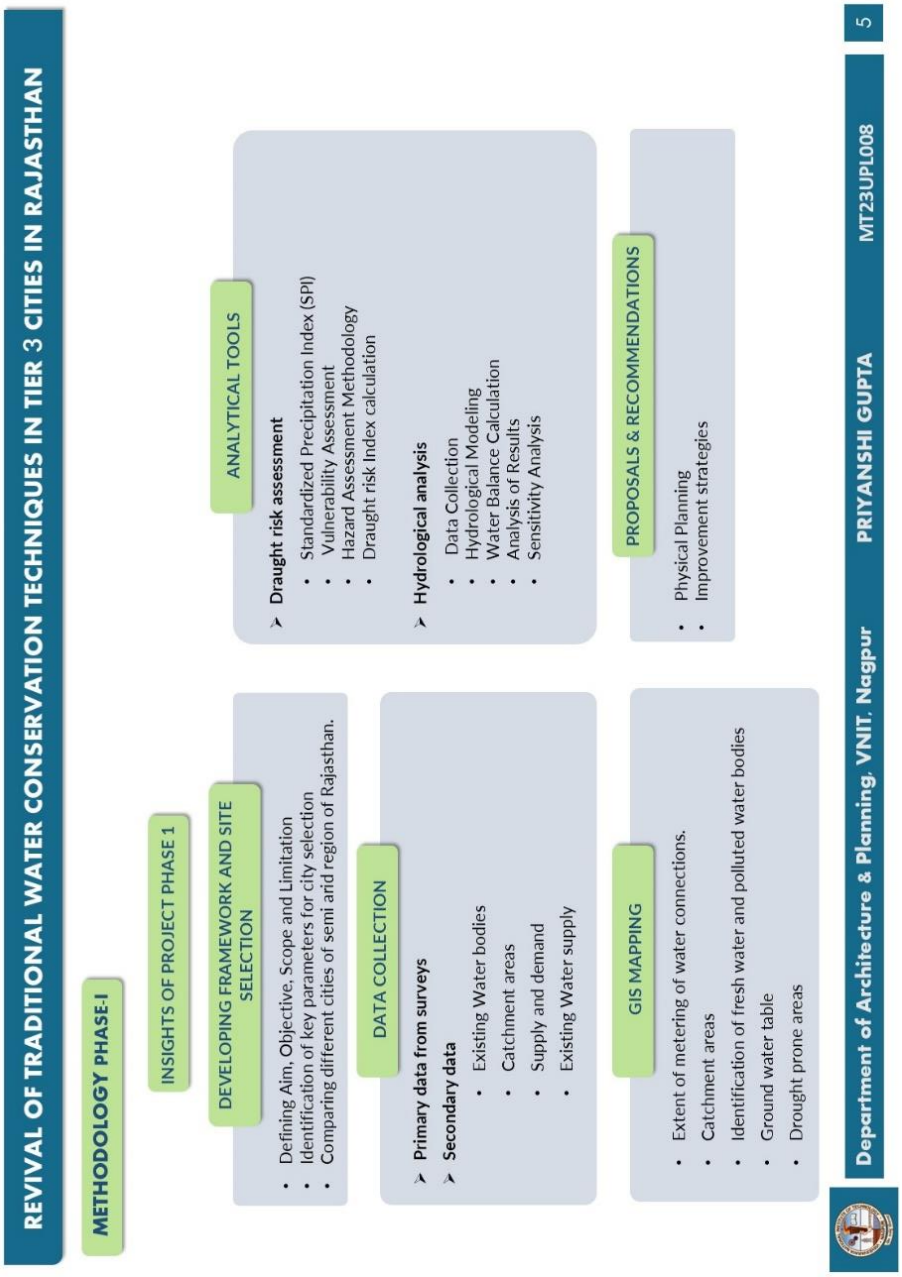

Figure 7- Methodology of the study (Source author)

Chapter -2

Literature Study

2.1 Traditional water Conservation Techniques

They are methods that have been used for centuries to manage water resources sustainably. Some traditional conservation techniques include Baoli, talabs, Kunds, bawdi, Khadin System etc.

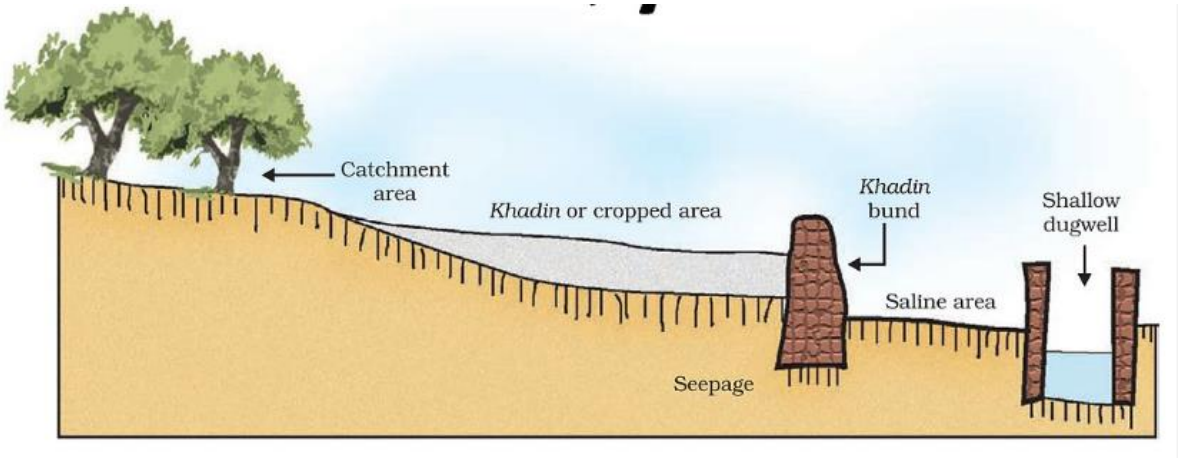

Figure 8 Section of a khadin System firstly used in Jaisalmer

The main features of these water supply systems are also their strengths in comparison to the modem modes of management were:

Location specific and suitable to local conditions.

Structure: Well-planned, technically correct, low cost, well designed, sustainable, sound engineering (long lasting), low O&M cost, made with local material, people friendly technology, no outside expert required to build or maintain.

Community management: Decentralized community/ individual manage

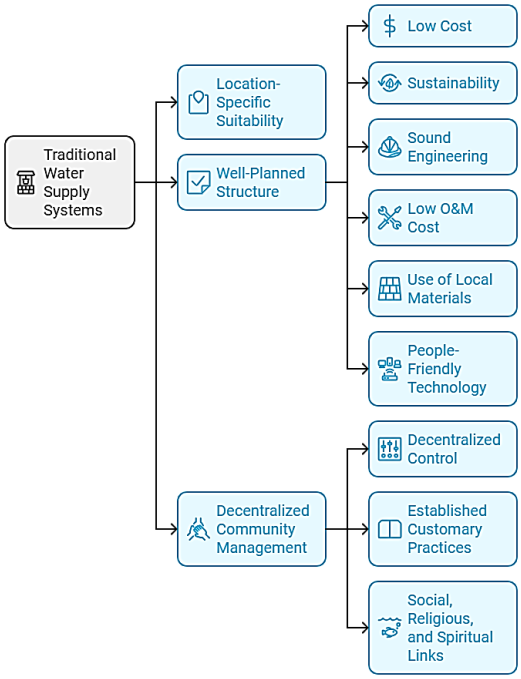

Figure 9 Features of Traditional Water Conservation Techniques

sustained by codes of established customary practices that were also linked to social, religious and spiritual activities around water bodies that ensured cleanliness, maintenance and community involvement. (Rathore, 2007)

2.2 Benefits of Traditional water Conservation Techniques

2.2.1 **Enhanced Water Security**: Increase water availability and reduce the demand on municipal water bodies

2.2.2 **Reduced Reliance on External Sources:** Decreased dependence on distant water sources, reducing transportation costs and environmental impacts.

2.2.3 **Improved Water Quality:** Natural filtration processes through wetlands and rainwater harvesting can improve water quality.

2.2.4 **Flood Risk Mitigation:** Water-sensitive urban design helps manage stormwater runoff, reducing the risk of flooding.

2.2.5 **Ecosystem Benefits:** Traditional techniques enhance biodiversity and ecosystem health by recharging ground water.

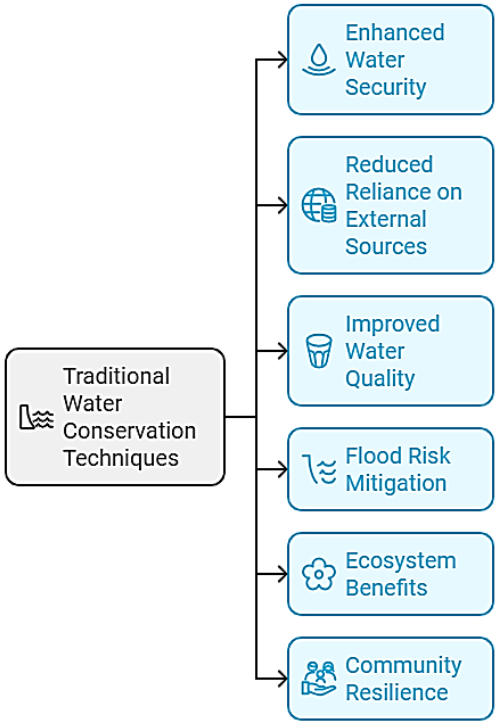

Figure 10 Benefits of Traditional Water Conservation Techniques

2.2.6 **Community Resilience:** Community-led management can foster a sense of ownership and resilience in the face of water scarcity.

2.3 Drawbacks of Traditional water Conservation Techniques

2.3.1 **High initial Cost and Maintenance:** Building and maintaining traditional structures can be costly and labor-intensive as compared with the availability of newer, cheaper sources such as pipes, etc. RWH systems require regular maintenance by periodically removing alluvial sediment (e.g., fine sand, silt, and clay) and organic materials such

as bacterial slime and algae.

2.3.2 **Limited Capacity:** Traditional systems often have limited storage capacity, which may not meet the increasing water demand due to population growth.

2.3.3 **Land Requirement:** RWH systems require sufficient land area for the collection and storage of rainwater.

2.3.4 **Water Quality Concerns:** Open water bodies are susceptible to contamination from various sources, including pollutants and biological contaminants. They can also be breeding space for mosquitoes leading to health problems. Covered systems are more hygienic but can be more expensive to build and maintain.

2.3.5 **Climate Dependence:** The effectiveness of these techniques is highly dependent on rainfall patterns and climatic conditions.

2.3.6 **Accessibility and Labor:** Traditional structures may be located far from residential areas, making it difficult for people to access water. Skilled labor for construction and maintenance may not be readily available. (Aklan, Fraiture, Hayde, & Moharam, 2022)

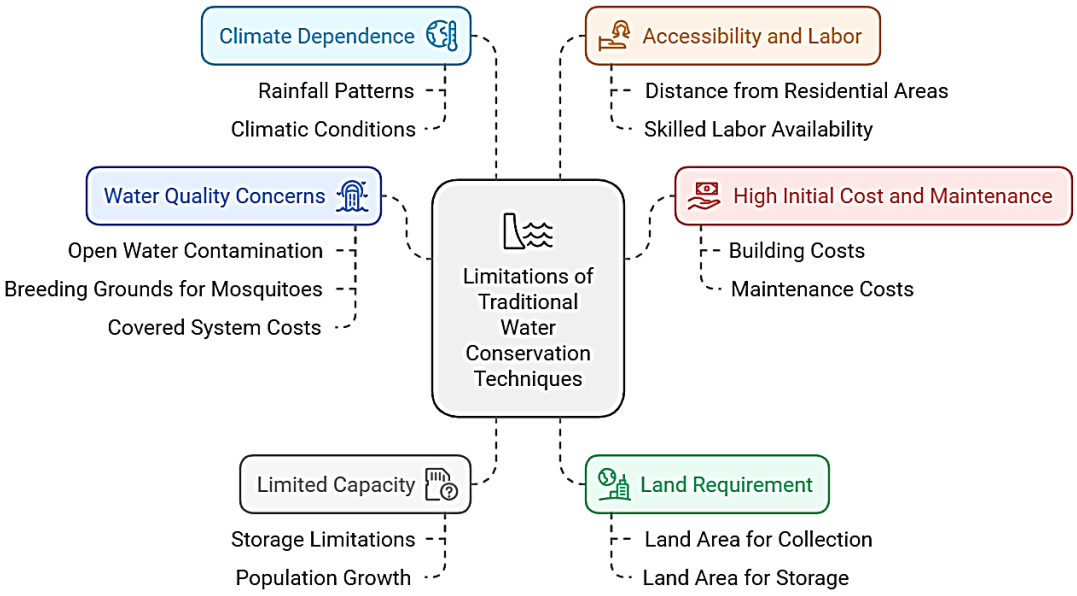

Figure 11 Drawbacks of Traditional water Conservation Techniques

2.4 Why traditional water conservation techniques have lost their

significance?

Introduction of laws based on the British system emphasized private ownership rights of individuals due to which individual and communities have steadily lost their role, almost completely, to the state in the management of water resources In 1863, the Public Works Department created. As a result, local control over Johars and *talaabs* was withdrawn and placed under the PWD.

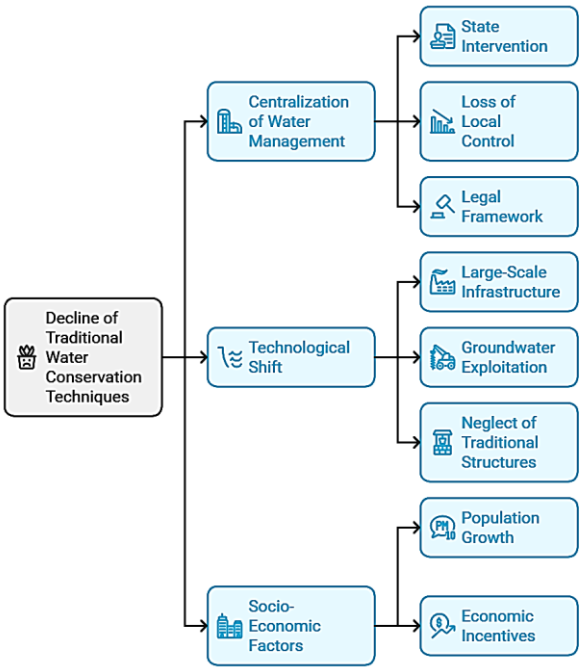

Figure 7 Reason of decline in Traditional Water Conservation Techniques

The introduction of modern property laws, often based on Western models, has undermined traditional communal rights over water resources. The focus on large-scale infrastructure projects like dams and canals has diverted attention from traditional techniques. The widespread use of groundwater extraction technologies as they require less efforts has led to depletion of aquifers and reduced reliance on surface water sources. Modern lifestyles, with increased consumption, availability of ground water resources and a shift towards convenience, have reduced the value of traditional practices. Rapid population growth and urbanization have increased water demand and put pressure on existing water resources. Economic incentives, such as subsidies for farmers for buying pumps and drilling wells at very favorable interest rates have encouraged unsustainable water use practices.

The introduction of British-based laws and modern development practices has significantly eroded traditional water management systems in India. These factors have led to a decline in community-based water management, increased reliance on large-scale infrastructure projects, overexploitation of groundwater, and a shift towards unsustainable water use practices.

2.5 Policies and Guidelines related to Conservation and restoration of Traditional Water bodies and Structures by Central Government

Water resources projects, including rainwater harvesting and water conservation, renovation of traditional water bodies and tanks, reuse of water and recharge structures, watershed development and afforestation, etc. are planned, funded, executed and maintained by the State Governments themselves as per their own resources and priorities. Role of Government of India is limited to being catalytic, providing technical support and in some cases partial financial assistance in terms with the ongoing schemes of Government of India.

- **Indicative Guidelines for Restoration of Water Bodies:** The Central Pollution Control Board (CPCB) provides these guidelines, which outline a systematic approach to studying, assessing water quality, identifying pollution sources, and planning for the restoration of ponds, lakes, and rivers. These guidelines are generally adopted by states for conservation and restoration efforts. (board, 2019)
- **Pradhan Mantri Krishi Sinchayee Yojana (PMKSY):** Provides financial assistance for repairing and renovating water bodies**, developing groundwater-based irrigation**, and promoting water conservation practices.
- **National Lake Conservation Project:** This project aims to restore and conserve existing lakes and other water bodies, promoting sustainable water management practices.
- **Central Ground Water Board (CGWB):** Provides scientific guidance and support for groundwater management and rainwater harvesting.
- **Ministry of Environment, Forest and Climate Change (MoEFCC):** Implements afforestation schemes to conserve water resources.
- **Jal Shakti Abhiyan:** Launched in 2019, this campaign focuses on rainwater harvesting, water conservation, and rejuvenating water bodies.
- **Census of Water Bodies:** Aims to create a national database of all water bodies in India.

- **Mahatma Gandhi National Rural Employment Guarantee Scheme (MNREGS):** Provides funding for water conservation works like underground dykes, earthen dams, and rainwater harvesting structures.
- **Atal Mission for Rejuvenation and Urban Transformation (AMRUT):** Includes rejuvenation of water bodies and promotion of water recycling and reuse in urban areas. (shakti, 2022)

Chapter -3

Study Area: Kishangarh

3.1 City Selection

From the map of India, it is evident that a significant portion of Rajasthan experiences deep and very deep-water levels. However, post-monsoon, there is a visible increase in the groundwater level, indicating the state's substantial potential for water conservation. Despite comprising 10% of India's total land mass, Rajasthan holds only 1.1% of the country's surface water, resulting in a disproportionate land-to-water ratio and a heavy reliance on groundwater. This dependence is further exacerbated by Rajasthan receiving the lowest amount of rainfall in the country.

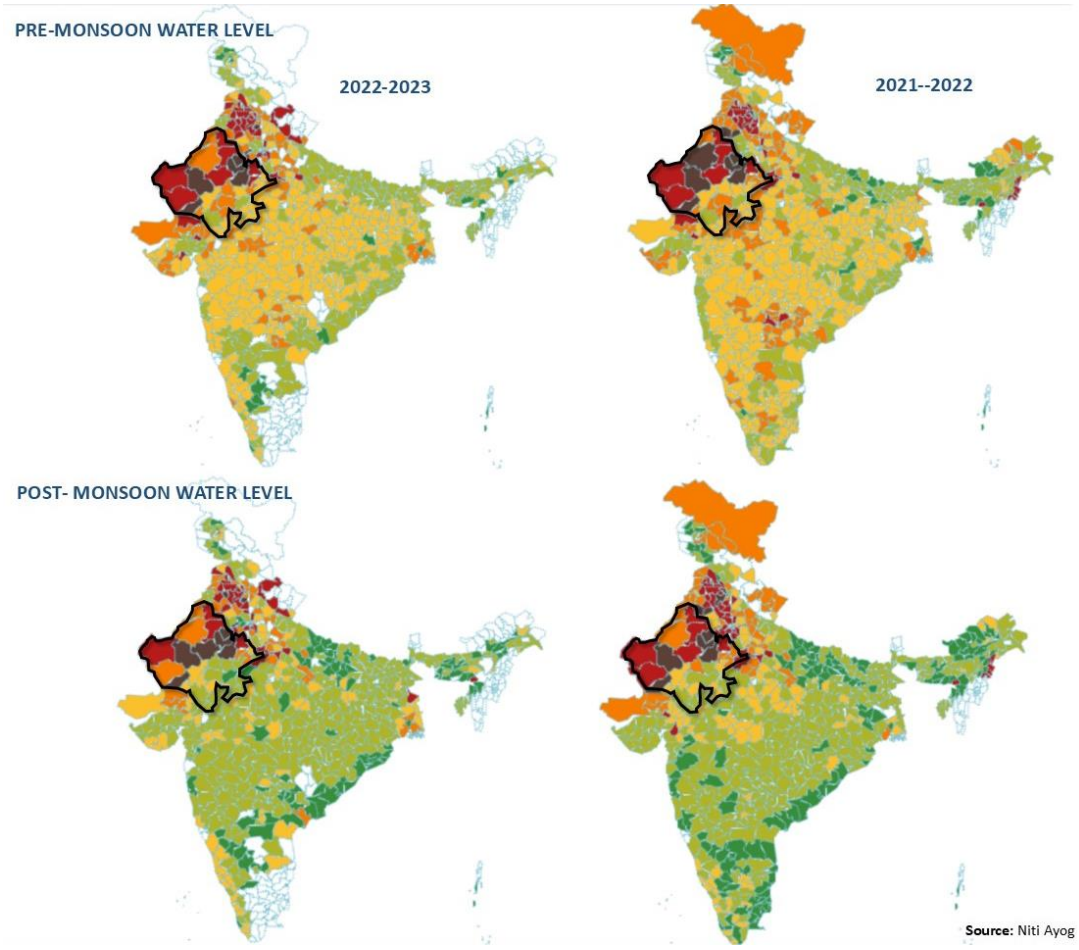

Figure 12 Ground Water level of India

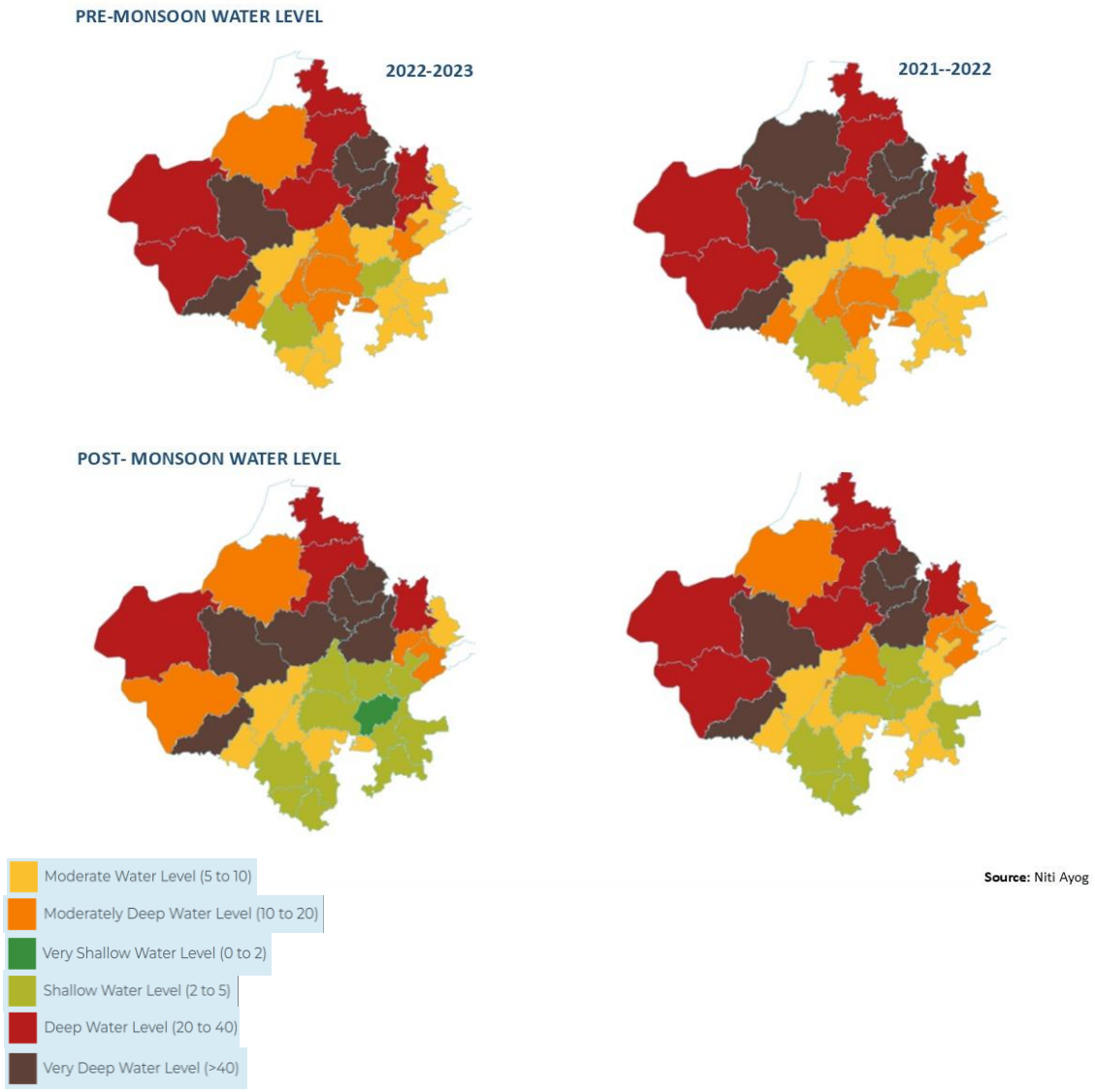
PRE-MONSOON WATER LEVEL
2022-2023
2021--2022
POST- MONSOON WATER LEVEL
Moderate Water Level (5 to 10)
Moderately Deep Water Level (10 to 20)
Very Shallow Water Level (0 to 2)
Shallow Water Level (2 to 5)
Deep Water Level (20 to 40)
Very Deep Water Level (>40)
Source: Niti Ayog

Figure 13 Ground water level of Rajasthan

Rajasthan's population, predominantly rural, relies heavily on agriculture and livestock. Due to a scarcity of rivers and natural water bodies, groundwater extraction in the state has surged by 114% since 1984. As of 2017, approximately 13,500 villages lacked access to safe drinking water, depending on water tankers.

Key issues contributing to this situation include:

- **Over-exploitation:** Groundwater extraction has significantly increased over the past three decades.

- **Lack of Regulation:** There is weak regulation and enforcement regarding groundwater extraction.
- **Illegal Water Supply:** Tanker operators illegally supply water to industries without proper permits or quality checks.
- **Ineffective Rainstorms:** Short and intense rainstorms are insufficient for recharging aquifers and water bodies.

Rajasthan was also chosen for this study because it has experienced 48 drought years of varying intensity between 1901 and 2002. This indicates a 47% probability of meteorological drought, which is the highest in India.

From Phase-I of the project, we concluded that traditional water conservation practices are most effective in Tier 3 or Tier 4 cities, aiding their self-sufficiency. Therefore, from the state of Rajasthan, Jaipur, being the capital (a major city), was selected. A 100 km radius circle was drawn from its city center, and the Tier 3 cities located within this circle were then studied and compared, as presented in the table below.

Figure 14 Districts in Rajasthan

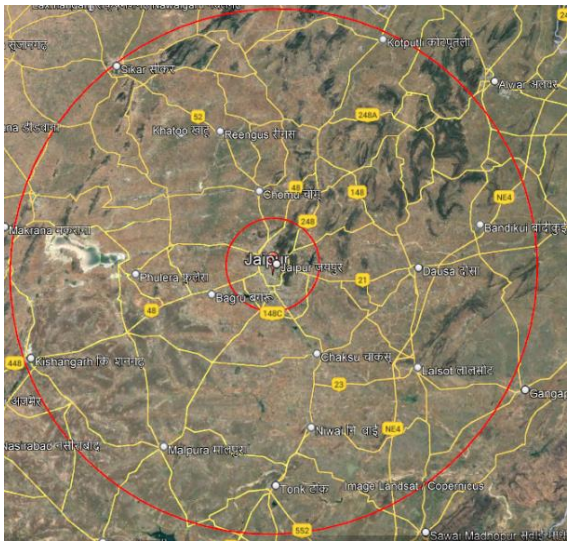

Figure 15 Map showing tier 3 cities coming in 100km radius of Jaipur

Cities within the 100 km range of Jaipur	Water Scarcity Issues	Historical Traditional Water Conservation Techniques	Potential for Revival	Challenges
Kishangarh	water scarcity due to reliance on groundwater.	Lakes and ponds	High potential due to strong historical ties to water conservation techniques.	Need for infrastructure improvements, high reliance on groundwater.
Makrana	Water shortage, especially due to marble industry water demand.	Bawris (stepwells), Ponds.	Significant potential for reviving traditional water bodies for both domestic and industrial use.	Balancing industrial water demands with traditional methods.
Tonk	Semi-arid region, suffers from seasonal water scarcity.	Tanks, Kunds.	Revival of tanks and kunds could help with water management, especially for agriculture.	Upgrading local infrastructure and addressing water demand variations.
Chaksu	Water scarcity due to declining groundwater levels.	Johads, Tanks.	Potential for improving water retention through traditional ponds and Johads.	Community cooperation and sufficient funding for restoration projects.
Dausa	Groundwater depletion, especially for agricultural needs.	Baolis, Johads.	Reviving Baolis and Johads could help meet both agricultural and domestic water needs.	Seasonal water scarcity and infrastructure challenges.
Bandikui	Water scarcity due to low rainfall and over-extraction of groundwater.	Kunds, Tanks.	Revival of Kunds and Tanks could provide localized water storage.	Sufficient government and community engagement required.
Reengus	Water scarcity, especially during dry seasons.	Ponds, Baolis.	Revival of ponds and Baolis for local water storage could improve water supply.	Limited local awareness and infrastructure development.
Sikar	Water scarcity due to limited groundwater recharge and high agricultural demands.	Johads, Baolis, Tanks.	High potential for restoring Johads and Tanks to manage water for agriculture.	Managing urban and rural water needs effectively.

Figure 16 Comparison of cities within 100 km of Jaipur

From the comparison shown in the table it is found that Kishangarh is the potential city for the study of the selected topic due to its strong historical ties to water conservation techniques.

3.2 Draught Risk Assessment

Step 1: Meteorological Drought Analysis (SPI-based)

SPI = Standardized Precipitation Index (calculated using long-term monthly rainfall) from the SPI study (1985–2008) for Ajmer

Kishangarh SPI-based droughts:

- Extreme Droughts: 2 events
- Severe Droughts: 6 events
- Moderate Droughts: 14 events
- Total Drought Events: 22
- Drought Intensity: -1.47
- Drought Duration: 22 months
- Total Severity: -32.37

Kishangarh experiences a drought every ~3 years, making it drought-prone.

Step 2: Calculate Drought Hazard Score (DHS)

Assign weights and ratings:

Category	Events	Weight (W)	Rating (R)	Score = W × R × No. of Events
Moderate Drought	14	2	2	14 × 2 × 2 = 56
Severe Drought	6	3	3	6 × 3 × 3 = 54
Extreme Drought	2	4	4	2 × 4 × 4 = 32

Table 2 Assigning of weights and ratings

DHS Kishangarh=56+54+32=142

Step 3: Normalize Drought Hazard Index (DHI)

Compare with maximum DHS in Ajmer region (Masuda = 1 Mild + 1 Moderate + 4 Severe + 4 Extreme):

DHS Masuda=1×1×1+1×2×2+4×3×3+4×4×4

=1+4+36+64=105

Kishangarh has **higher score**, so normalize across all stations (assuming 142 is max):

DHI Kishangarh=142/142=1.00

Step 4: Calculate Drought Vulnerability Index (DVI)

You need four socio-economic indicators, normalized (0–1):

Indicator	Value	Normalized (0–1)
IL = Irrigated land (%)	60%	0.6
TAL = Total Agricultural land (%)	80%	0.8
PD = Population density (per km²)	300/km²	0.75
MW = Municipal water use	Moderate	0.65

Table 3 Socio-economic indicators

$$\text{DVI} = \frac{0.60 + 0.80 + 0.75 + 0.65}{4} = \boxed{0.70}$$

Step 5: Calculate Drought Risk Index (DRI)

$$\text{DRI} = \text{DHI} \times \text{DVI} = 1.00 \times 0.70 = \boxed{0.70}$$

Final Drought Risk Classification for Kishangarh:

Index	Value	Classification
DHI	1	Very High
DVI	0.7	High
DRI	0.7	High Risk

Table 4 Draught risk classification of Kishangarh

Step	Value	Notes
DHS	142	From SPI drought frequencies
DHI (normalized)	1	Max score in the district

DVI	0.7	Based on socio-economic factors
DRI	**0.7**	Final drought risk level
Risk Class	**High**	Needs mitigation focus

Table 5 Summary of Draught risk assessment of Kishangarh

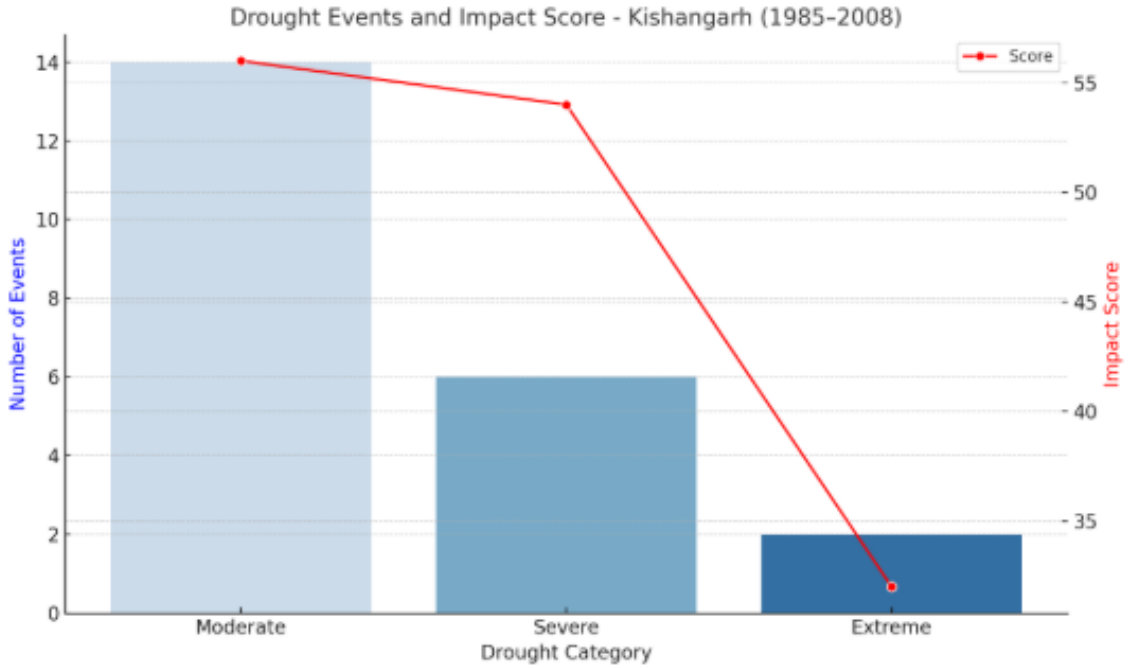

Figure 17 visual graph for Kishangarh's Drought Risk Analysis (1985–2008):

The blue bars show the number of drought events in each category (Moderate, Severe, Extreme). The red line represents the impact score (Events × Weight × Rating), which reflects the severity contribution of each drought type to the total hazard score.

Key Insights:

Moderate droughts occurred most frequently but had moderate impact. Severe and extreme droughts, though less frequent, contribute significantly to the total drought risk due to higher severity ratings. (Gaurav Sharma, 2020)

3.3 City profile

Kishangarh, located in Rajasthan's Ajmer district, is a prominent town with a population of **154,886** as per the 2011 Census. Positioned about **26 km northeast of Ajmer**, it enjoys strong connectivity via **National Highway 8**, **Indian Railways**, and its own **airport**. Historically a

princely state, Kishangarh was established in **1609** by Prince **Kishan Singh of Jodhpur**, succeeding **Raja Samokhan Singh**.

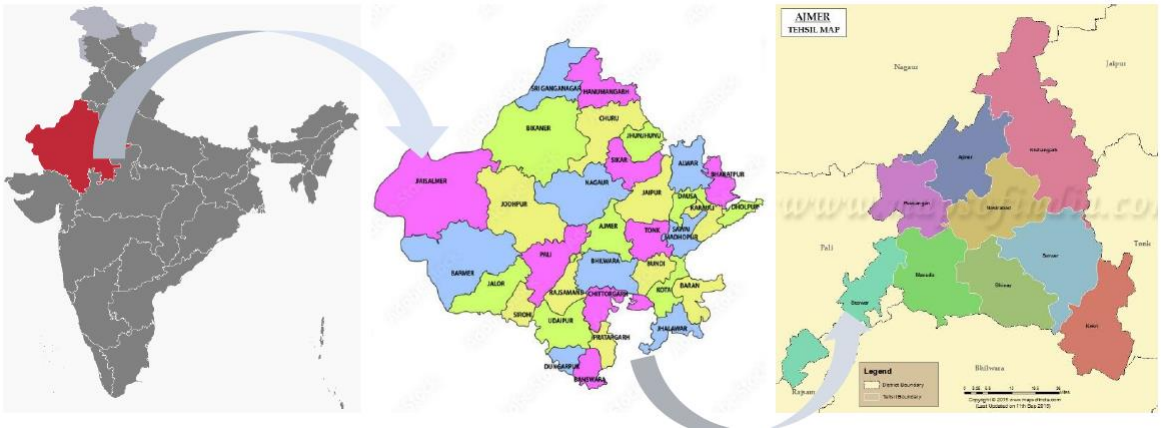

Figure 18 Location of Kishangarh

This is a **regional connectivity map** showing **Kishangarh's strategic location** within central Rajasthan and its accessibility to major cities via road and rail networks.

Figure 19 Regional setting of Kishangarh

The town is famed for its unique style of painting known as **Bani Thani**, and is widely

recognized as the **marble capital of India** due to its thriving **marble processing industry**. As a growing urban hub, Kishangarh plays a key role in the urban development of the Ajmer district.

Figure 20 Areial view of Kishangarh

Historically, the Kishangarh state covered an area of **2,210 km²** and had a population of **90,970** in 1901—a notable **27% drop** from the 1891 census, likely due to the **famine of 1899–1900**. According to the 2011 Census:

- **Males** make up **51%**, and **females 49%** of the population.
- The **literacy rate** stands at **68%** (national average is 74%), with male literacy at **75%** and female literacy at **60%**.
- Around **14%** of the population is under **6 years of age**.

Kishangarh is also home to the **Nepheline Syenite geological site**, recognized by the **Geological Survey of India (GSI)** as one of **32 National Geological Monuments**. This site, located within the **Aravalli craton**, features plutonic rock formations dating back **1.59 to 1.91 billion years**.

The city also hosts the **largest marble industry in the world**, employing nearly **100,000** people. Besides its economic significance, Kishangarh is celebrated for its **cultural heritage**,

including the **Kishangarh Fort**, **Phool Mahal Palace**, and traditional art forms. Today, it continues to grow as a center for **industrial activity**, particularly in **marble and textiles**. (department T. P.)

CITY	Kishangarh- Marble City of India (Ajmer)
Population, area and elevation	154,886 (2011 Census), 58 km2 (345.86 sq mi) and Elevation 433 m (1,421 ft)
Climate	Semi-Arid
Per capita water supply	66L/person/day
Community	79.39 % Hindu, 14.8% muslims and 5.5% jain
Presence of Traditional water conservation methods and structures	Gundolav Lake, Hamir Pond, and Santolav Pond, Ranamanad sagar lake
Average annual Rainfall	473mm
Surface water body	Gundolav Lake, Hamir Pond, Santolav Pond, and Ransamand Pond.
Ground water level	Pre 22 Av.depth to WL (mbgl) - 60.50 Post 22 Av.depth to WL (mbgl)- 58.67

Table 6 Data related to Kishangarh

3.4 Historical Significance of Kishangarh

Kishangarh's origins date back to **1470 AD**, when **Seth Gunda Shah Agarwal** developed the city's traditional water management system by constructing the **Gundolav Lake**, its **perimeter wall**, and an interconnected network of **canals and tributaries**. The city itself was officially founded in **1611** by **Kishan Singh**, a younger brother of the Maharaja of Jodhpur. Later, in **1653**, **Maharaja Roop Singh** constructed the **Kishangarh Fort**, around which the **old city (Purana Sheher)** developed.

During the **colonial era**, Kishangarh experienced a wave of modern transformation beginning in **1868**, when the **Delhi–Ahmedabad railway line** was introduced, and a railway station was established at **Madanganj**, bringing increased connectivity. In **1915**, the **Maharaja Cotton Mill** was set up along the Jaipur–Ajmer highway, catalyzing industrial growth. Further development occurred in **1947** after India's partition, as **refugees resettled** in newly developed areas to the **north of Gundolav Lake**.

By **1967**, the establishment of the **Aditya Mill** in the Madanganj area, along with the development of **public amenities** between **Kishangarh and Madanganj**, helped unify the two settlements. The **1980s** saw the construction of the **Ajmer–Jaipur bypass** north of Madanganj, which further accelerated urban growth. Additionally, **industrial parks** developed by **RIICO** along the **Roopangarh road** transformed Kishangarh into a major **marble processing and trading hub**.

In the **1990s and early 2000s**, Kishangarh was included under the **Indira Nagar Awasiya Yojana** as part of the **Integrated Development of Small and Medium Towns (IDSMT)** scheme, leading to planned housing and urban expansion. Today, the city's historical roots, traditional water systems, and industrial growth together shape its identity as a unique blend of heritage and modernity.

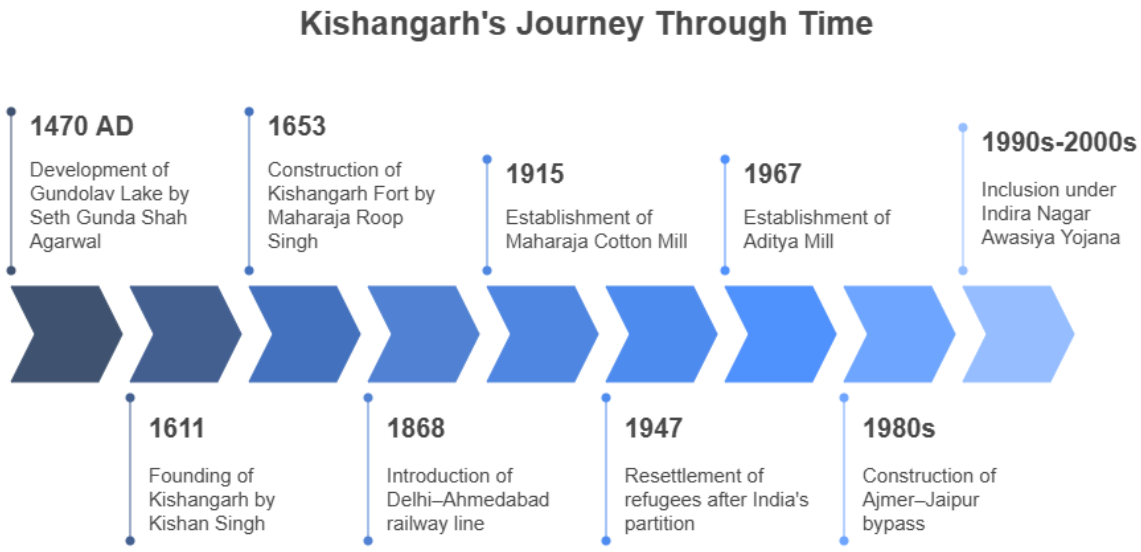

Figure 21 History of Kishangarh

3.5 Demography

The growth and development of any city, town, or region are intrinsically linked to a range of factors — natural, physical, and socioeconomic. Among these, **population dynamics** play a pivotal role in shaping future patterns of development and urban expansion. The demographic profile of the **Kishangarh Planning Area** is based on data from secondary sources, including the **Census of India, 2011**.

Kishangarh town has witnessed **consistent and steady population growth** over the past five

decades, as reflected in census records:

- In **1971**, the population was **37,405**.
- By **1981**, it had grown to **62,032**, marking a substantial **growth rate of 67.45%**.
- In **1991**, the population reached **81,948**, registering a decadal growth of **32.10%**.
- In **2001**, the figure rose sharply to **116,222**, indicating a **41.82%** increase.
- The **2011 Census** reported a population of **154,886**, reflecting a further **33.26% growth**.

This sustained growth trend suggests a steadily expanding urban footprint. Based on historical patterns and **graphical population projection**, the **estimated population of Kishangarh in 2025** is approximately **190,402**. This projection underscores the ongoing process of urbanization and the increasing demographic pressure on the town's infrastructure and resources.

Year	Population	Increment	Decadal Growth Rate
1971	37045	-	
1981	62032	24987	67.45%
1991	81948	19916	32.10%
2001	116222	34274	41.82%
2011	154886	38664	33.26%
2024	190402	35516	22.93%

Figure 22 Demographics trends

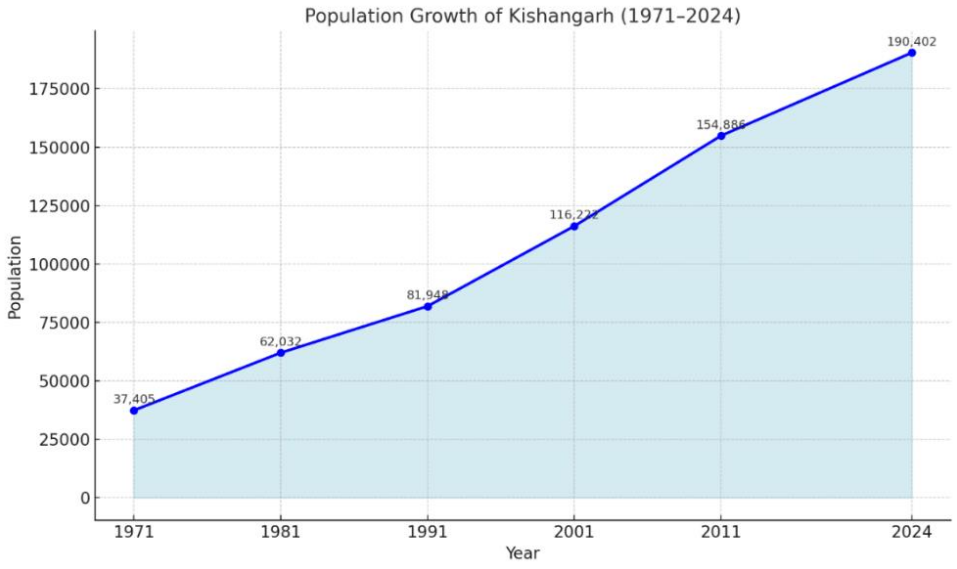

Figure 23 Graph showing Population growth of Kishangarh (1971-2024)

The trend clearly shows **steady and substantial growth** over each decade.

Year	1981	1991	2001	2011	2021
Number of Wards	24	30	40	45	60

Source: District Census Handbook 2011

Figure 24 Wardwise growth of Kishangarh

3.6 Land use

Kishangarh operates under a **Municipal Council (Nagar Parishad)**, which serves as the local self-governing body for the city. The **Chief Municipal Officer** leads the executive functions, working in consultation with an elected **Council Member** who represents public interests. The primary duties of the Nagar Parishad include managing **sanitation and sewerage systems**. In the absence of a dedicated **Development Authority**, the Nagar Parishad is also responsible for **approving building plans** and **permitting land use changes** within the city.

Land use plan of 2025

At present the Landuse is distributed within the Urbanisable area (2031) which constitutes of an area 9798 hectares. Both Residential and Industrial zones are distinctly separated from the major NH 8 highway.

The northern and western parts of the city, along the Rupangarh road, between the Ajmer-Jaipur bypass and the railway line, along the Bhilwara bypass near Silora, and the Khoda Ganesh Road and Dhani Purohitan, are the populated parts of the city. The southern and north-east parts of the city are hilly and barely populated.

The expansion of the city's municipal area and the growth of industries like the marble industry have contributed to urban sprawl, with the development of residential, commercial, and industrial spaces in an unplanned manner towards the north and southwest directions.

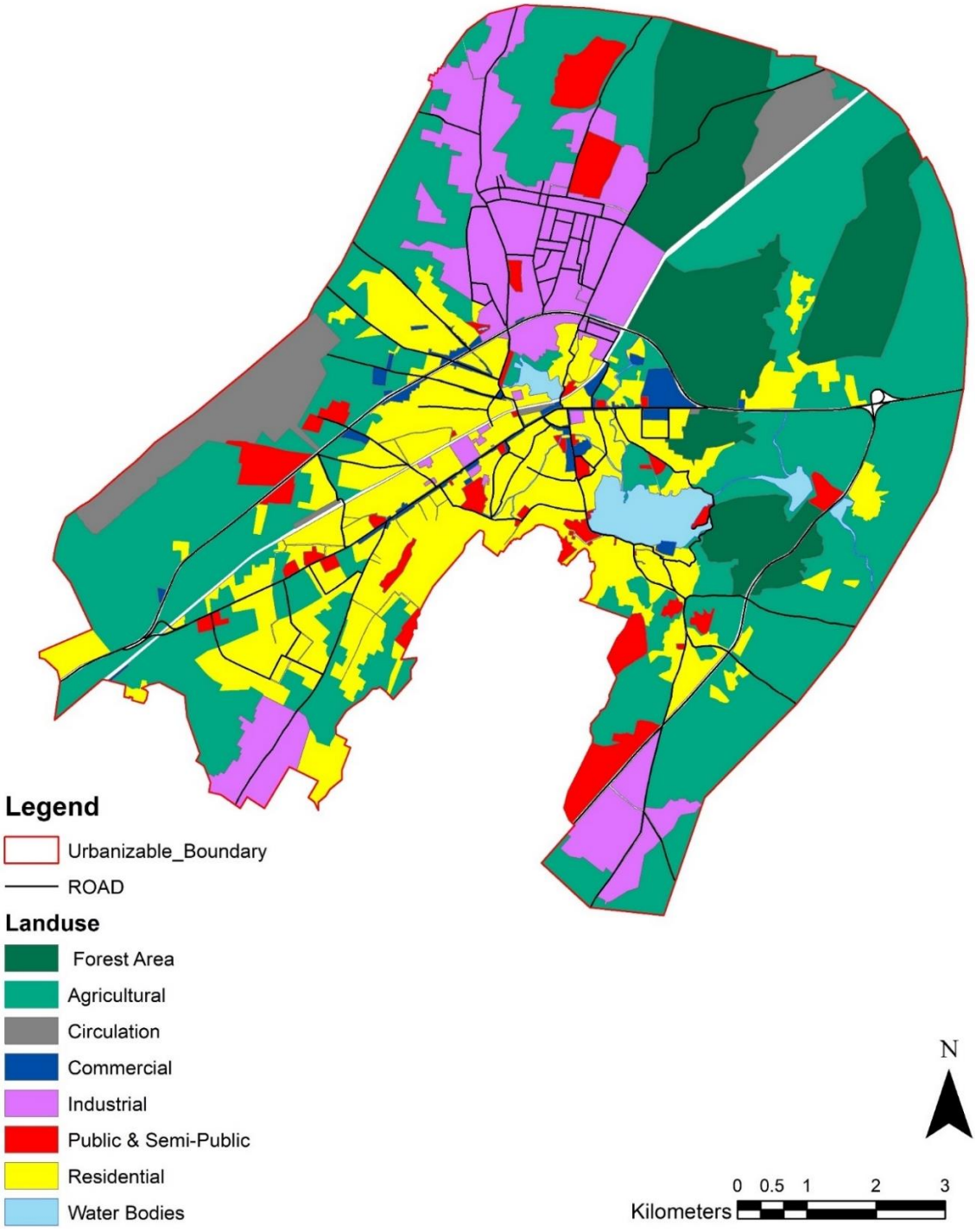

Figure 25 Land use plan of 2025

Proposed Land use of 2031

As per the Land use projections for 2031, it is expanding towards Narsirabad road, specifically in the direction of Silora. Commercial areas are predominantly located along the higher

Hierarchy of Roads; however, their growth is not uniform across these areas.

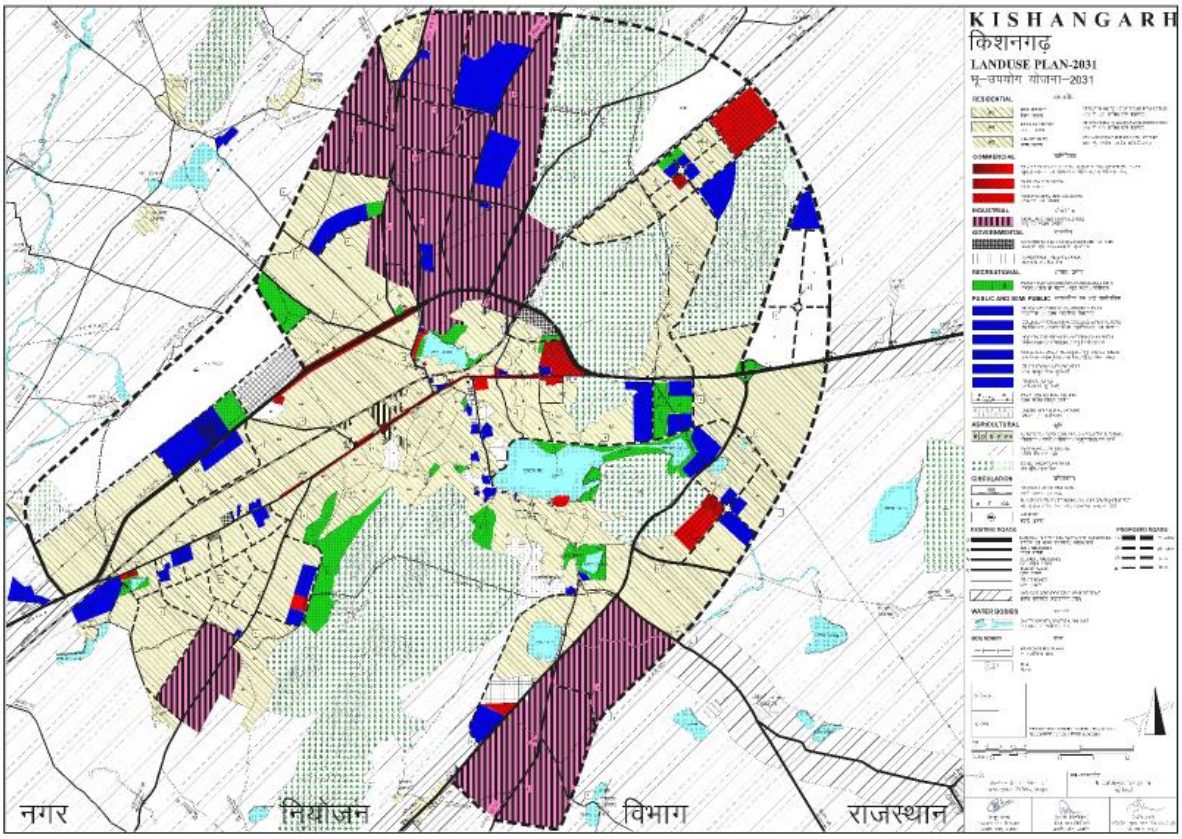

Figure 26 Proposed land use plan of 2031

3.7 Ecological profile

3.7.1 Aquifer System

Groundwater is mainly found in hard rock formations, which have limited space for recharge.

Geology: Aquifer system consists of alluvium layers followed by schist/gneiss rocks. These are crystalline and metamorphic rocks, generally low in porosity and permeability.

Type and Nature of Aquifer: Unconfined Aquifer

This means the aquifer is directly open to the atmosphere and recharged through rainfall or surface infiltration. The water table fluctuates depending on rainfall and

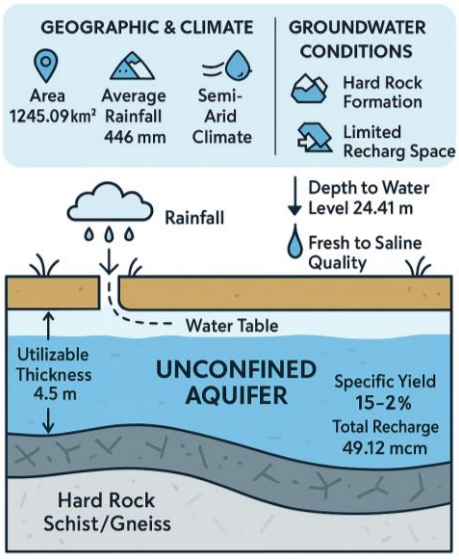

Figure 27 Aquifer system of Kishangarh

extraction. (BOARD, 2017)

3.7.2 Soil type

Cambic Arenosols cover the majority of the mapped area. These are sandy soils with low fertility, high permeability, and poor water retention — typically less suitable for intensive agriculture without soil amendments. **Eutric Cambisols** are present in a smaller strip on the eastern edge (in southeastern region). These are loamy to clayey soils with high fertility, good structure, and strong agricultural potential — ideal for a wide range of crops.

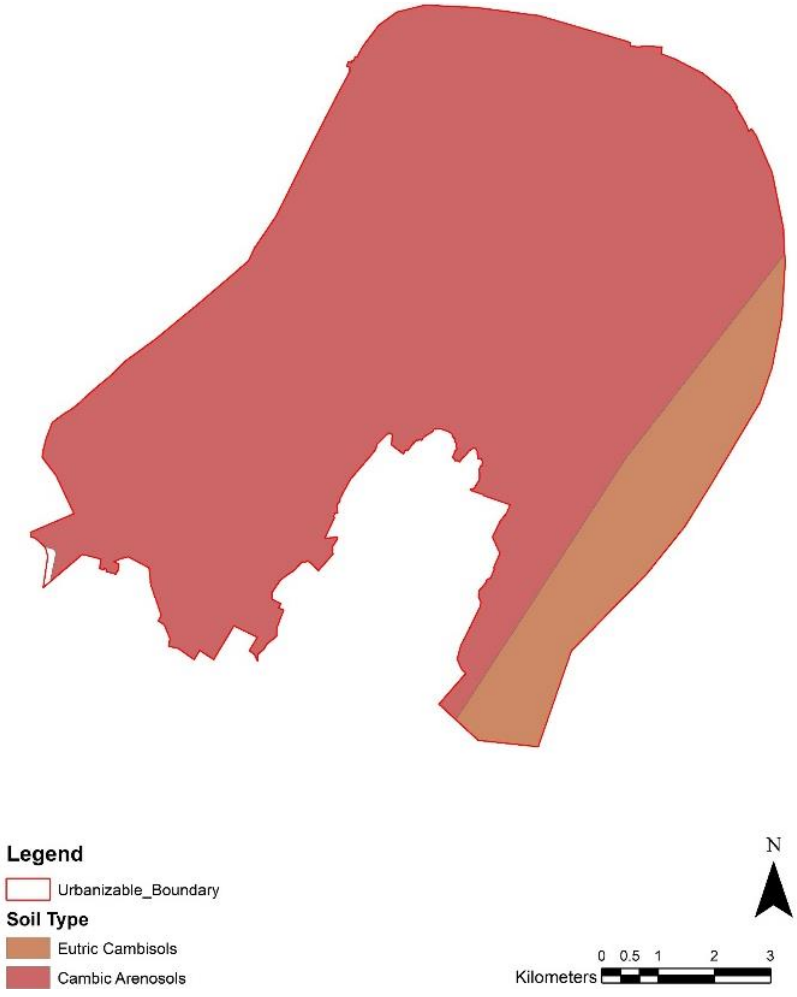

Figure 28 Soil Map of Kishangarh

Cambic Arenosols

Cambic Arenosols are sandy soils with a weakly developed subsurface horizon (cambic). While they offer good drainage and aeration, they present several limitations for agriculture

due to their low nutrient and water retention capacity.

- **Physical Properties:**
    - **Texture:** Predominantly sandy
    - **Permeability:** High; allows rapid water movement
    - **Drainage:** Very quick, leading to water loss
    - **Water Retention:** Poor, making them highly susceptible to drought
    - **Structure:** Structureless or weak; prone to erosion and compaction
    - **Aeration:** Good, which supports root respiration but increases nutrient volatilization
- **Chemical Properties:**
    - **Organic Matter Content:** Low
    - **Cation Exchange Capacity (CEC):** Low; unable to retain positively charged nutrients effectively
    - **pH:** Neutral to mildly alkaline (generally favorable for plant growth)
- **Agricultural Suitability:**
    - **Overall Productivity:** Low
    - **Constraints:**
        - Rapid leaching of nutrients
        - Limited moisture retention
        - Poor structural stability

Generally unsuitable for intensive agriculture without substantial soil improvement measures (e.g., organic amendments, mulching, moisture conservation practices)

Eutric Cambisols

Eutric Cambisols are fertile, loamy to clayey soils with a well-developed B horizon and relatively high organic matter content. These soils are commonly found in temperate regions and are among the most agriculturally productive.

- **Physical Properties:**
    - **Texture:** Loamy to clayey; balanced proportions of sand, silt, and clay

- **Structure:** Granular and well-formed, enhancing aeration and water movement
- **Organic Matter:** High, especially in upper layers
- **Water Holding:** Good retention with moderate drainage — ideal for plant growth

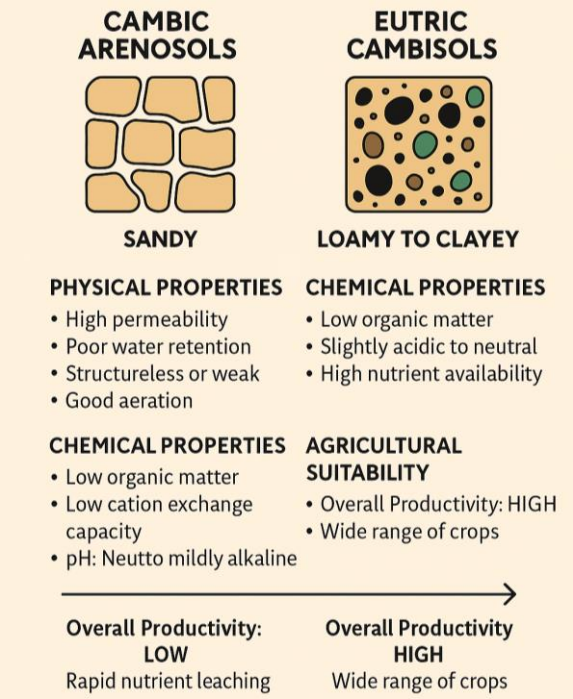

Figure 29 Properties of Soil

- **Chemical Properties:**
  - **pH:** Slightly acidic to neutral (6.0–7.0); optimum range for nutrient uptake
  - **Nutrient Availability:** High levels of essential nutrients like nitrogen, phosphorus, and potassium
  - **Organic Content:** Enhances nutrient cycling and microbial activity
- **Agricultural Suitability:**
  - Overall Productivity: High
  - Strengths: Balanced moisture and nutrient availability and suitable for a wide range of crops
  - Crops Supported: Cereals, legumes, vegetables, and fruit trees

Excellent for sustainable, high-yield agriculture with minimal soil amendments.

Property	Cambic Arenosols	Eutric Cambisols
Texture	Sandy	Loamy to clayey
Water Retention	Low	Moderate to high
Drainage	Rapid	Moderate (well-balanced)
Structure	Weak or absent	Well-developed, granular
Organic Matter	Low	High
CEC (nutrient retention)	Low	High

pH	Neutral to mildly alkaline	Slightly acidic to neutral
Agricultural Suitability	Low	Very high

Table 7 Properties of soils

3.7.3 Slope and Contour

The slope of the city gradually descends toward the central water body, as evident from the contour patterns. Higher elevations lie on the outer regions, especially to the north and east, while the terrain gently slopes inward. This natural gradient facilitates surface runoff toward the lake. It also highlights the lake's role as a catchment for the surrounding urban area.

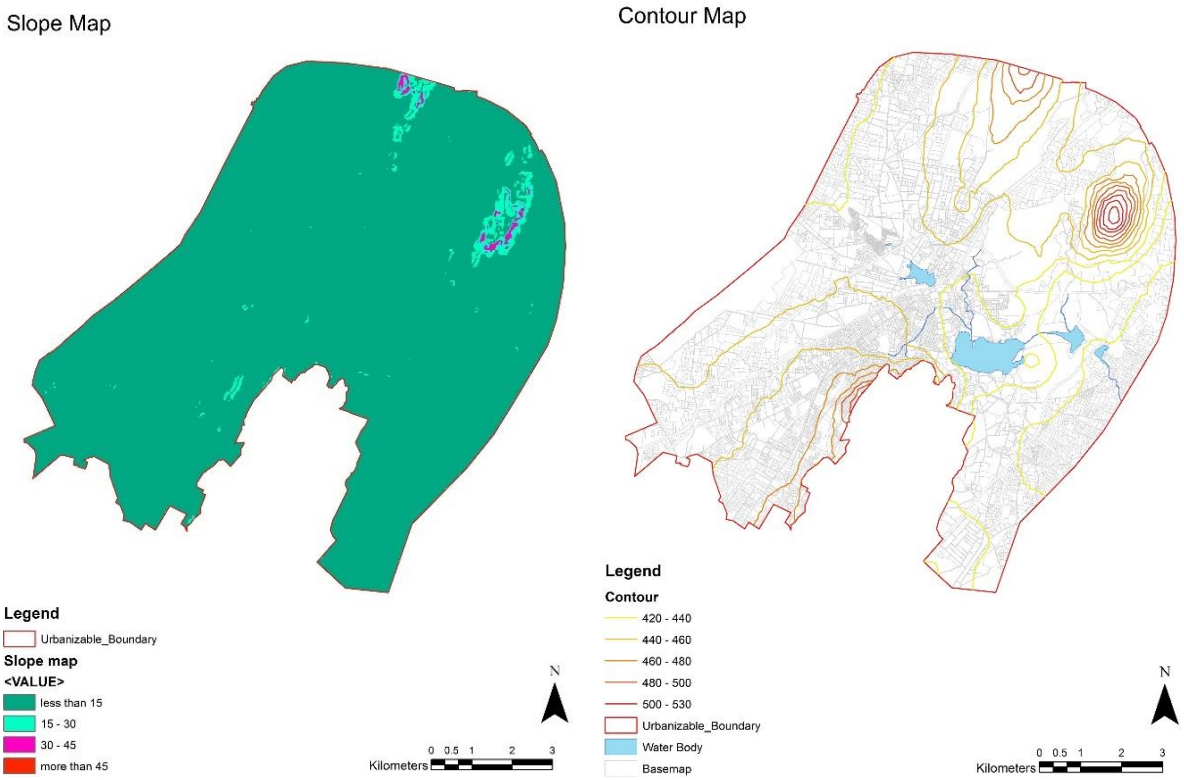

Figure 30 Slope and Contour map of Kishangarh

3.8 Economic Profile

Kishangarh is one of the major cities in Rajasthan which is also known as the marble city of India. It has developed as a major industrial center in Ajmer district which is handled by Marble Association.

It is noted that there are almost more than 9000 marble seller units in the city that also employed Fifty thousand direct & indirect persons in Industrial sector. Kishangarh marble

market becomes Asia's biggest marble market and no. 2 in the World.

According to the Delhi-Mumbai Industrial Development Corridor (DMIC) embraces parts of six States and 89 Districts and has an estimated population of 231 million in 2009. At the heart of the Corridor will be a new dedicated freight railway. Twenty-four regions comprising of industrial regions (IRs) and industrial areas (IAs) of 100-200 sq kms have also been identified across the Corridor to facilitate growth

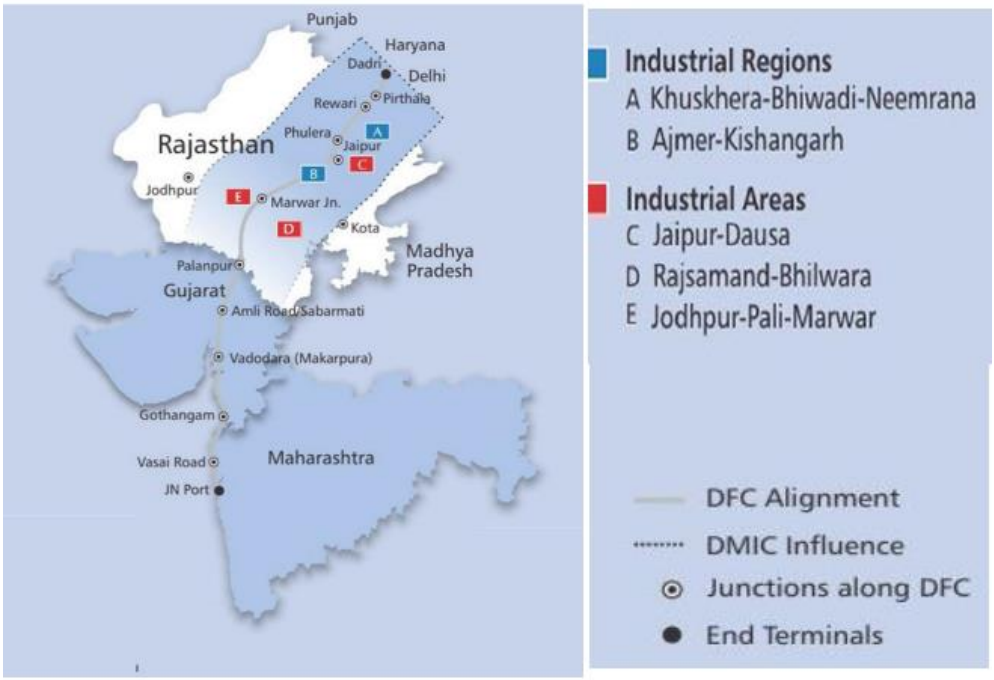

Figure 31 Delhi Mumbai Industrial Development Corridor

Growth pattern of Industrial Land use

Over the years, the marble industry experienced significant growth, turning Kishangarh into a prominent center for marble processing and trading. The growth direction of industries was seen expanding on the scattered chunks of Land use as per previous master plans.

This growth attracted investments and entrepreneurs, leading to the establishment of numerous marble factories and trading hubs making Kishangarh a Industrial town. Also diversification over time, with the emergence of industries such as textiles, ceramics, chemicals, and agro-processing. helped reduce dependence on a single sector and contributed to overall industrial growth. Infrastructure development facilitated industrial activities by enhancing connectivity to markets and raw materials. Government initiatives, such as

incentives, subsidies, and policy reforms, aimed at promoting industrial development, encouraging investment, entrepreneurship, and the adoption of modern technologies.

Figure 32 Growth pattern of Industrial Land use

The city's industrial products, particularly marble, gained recognition in both domestic and international markets, contributing significantly to industrial growth and foreign exchange earnings. Technological advancements, including automation, mechanization, and digitalization, have improved productivity, quality, and competitiveness in Kishangarh's industries. Despite this growth, challenges such as environmental concerns, infrastructural limitations, and market fluctuations persist.

The industrial area has increased almost 12 times from 1989 to 2011, doubling from what was proposed in 2011. It is estimated to increase by 3 times from 2011 to 2031, with 75% of the

development for 2031 already achieved by 2025. Therefore, it is projected that the Industrial land use will reach up to 3000 hectares by 2041.

Indus. Land Use	AREA (ha.)	Increment	Growth %
Existing 1989	38.96		
Existing 2011	478	+440	91.8
Existing 2024	1016.03	+538	52.9
Proposed 2031	1886	+870	46.1

Figure 33 Increament in Industrial land use

3.9 Physical Infrastructure

3.9.1 Water Supply

Traditional Water System of Kishangarh

The traditional water management system of Kishangarh, dating back to **1470 AD**, was developed by **Seth Gunda Shah Agarwal**, who constructed the **Gundolav Lake**, its **perimeter wall**, and an intricate network of **canals and tributaries**. This system was designed to collect, distribute, and store water using the city's natural topography and rainfall.

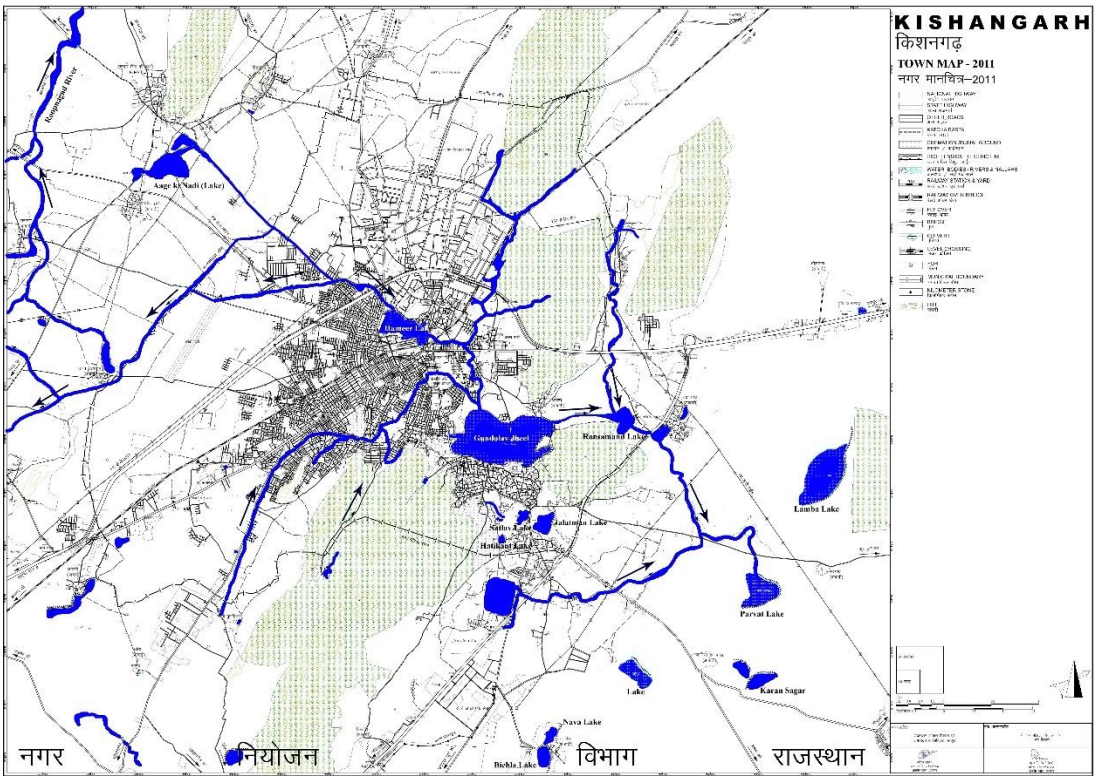

Figure 34 Linkages and interconnection of traditional water system

This interconnected structure formed a **"part-to-whole" strategy** of water circulation, where each tributary played a role in feeding the primary lake. It exemplified early hydrological planning that supported urban development, managed stormwater, and replenished groundwater.

The major water bodies in the city—**Hameer Talab**, **Gundolav Lake**, **Ransamand Pond**, **Sumer Sagar**, and **Satolav Talav**—were all interconnected through this canal system. Together, they created a self-sustaining urban water network that helped in **preventing floods**, mitigating **droughts**, and supplying **fresh water** across the town.

Gundolav Lake, the largest and most significant, became the focal point around which the **Kishangarh Fort** and early settlements developed. Water from **Hameer Sagar** naturally overflowed into Gundolav, showcasing a gravity-driven water management design.

Key components of this historic system are shown in the image:

Figure 35 Showing tributaries of the canal and route with region M1 and M2 where rainwater goes from Aravalli M=mountain and TR1, TR2, and TR3 show the respective path. TR=Tributary

- The **Old Canal**, originating from the **Aravalli foothills M1**, which distributed water throughout the city and drained into **Gundolav Lake**.

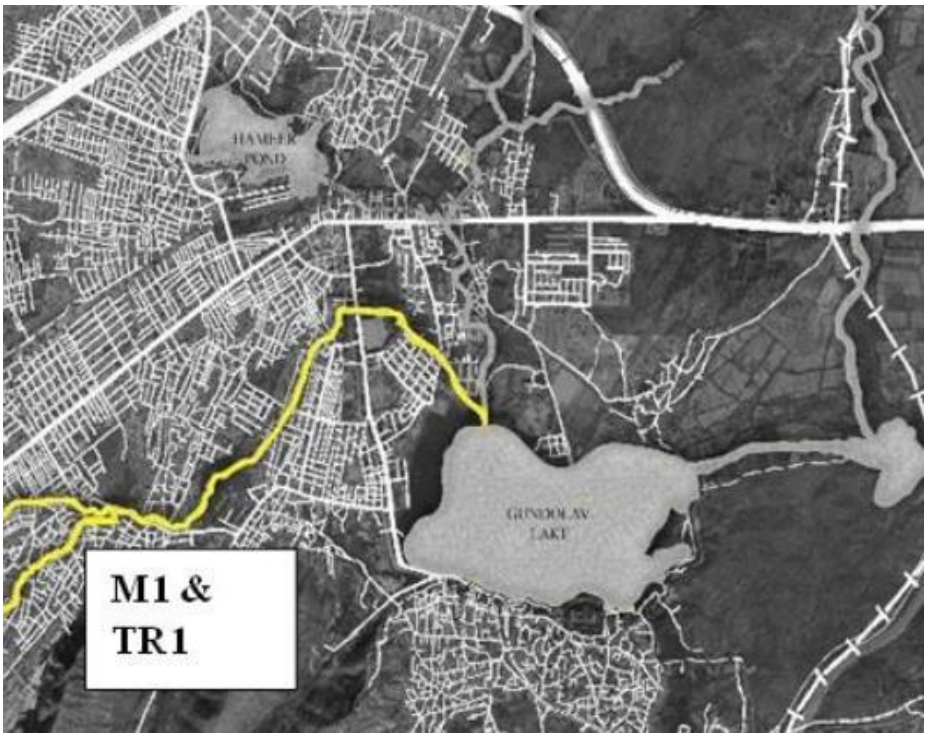

Figure 36 Showing path of old canal passing through city and merging with the Gundolav =M1 and TR1

- The **Spruit (TR3)**, emerging from another hill (M2), merged with **Hameer Talab Ki Aaw (TR2)**, which itself originated from **Hameer Talab**, before both discharged into Gundolav Lake.

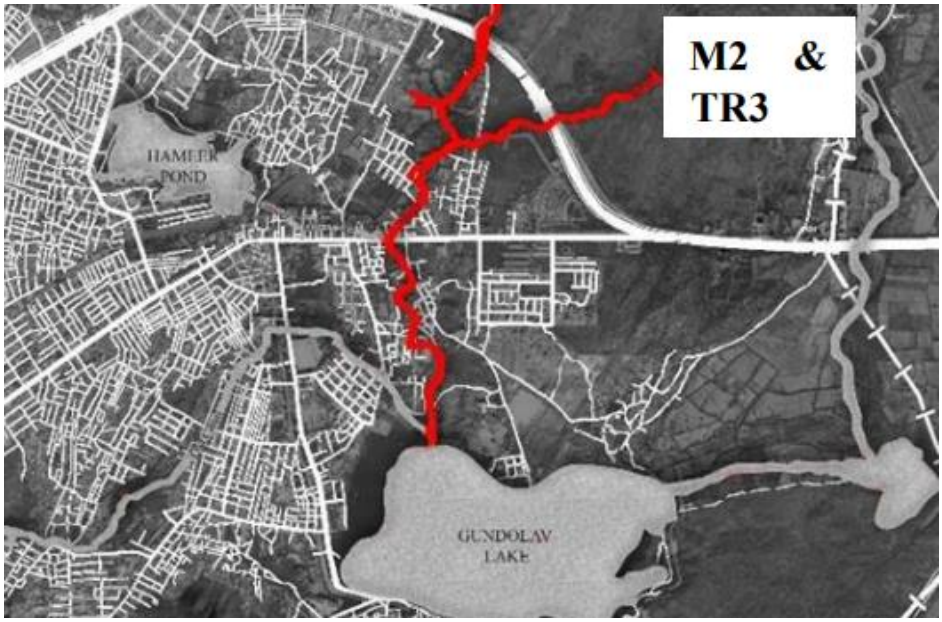

Figure 37 Hameer Talab Ki Aaw path passing through city and merges with the Gundolav

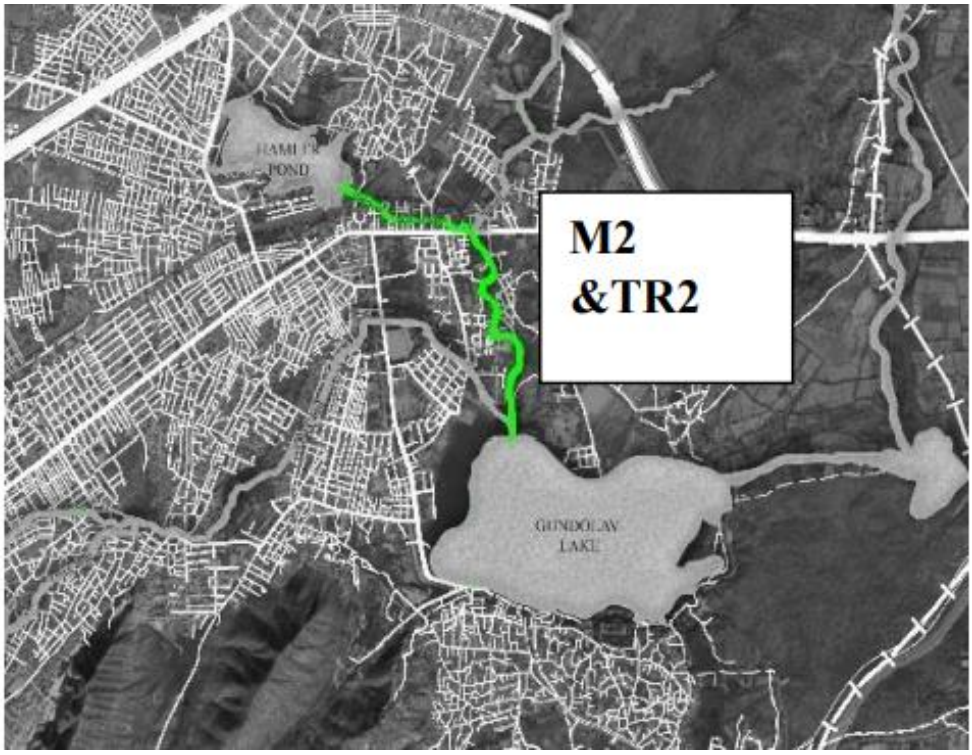

Figure 38 Hameer Talab Ki Aaw path passing through city and merges with the Gundolav

Over time, however, the efficiency and health of this system declined due to:

- **Urban encroachments** into drainage channels and catchment areas
- **Dumping of untreated wastewater and solid waste**
- Lack of **maintenance and conservation**

As pollution increased and water quality deteriorated—especially in Gundolav Lake—the city gradually transitioned to sourcing its water from the **Bisalpur Dam**, marking a shift away from its historic, localized, and ecologically integrated water system.

These lakes not only supported daily water needs but also functioned as stormwater reservoirs, helping maintain ecological balance and recharge groundwater in the region's semi-arid landscape.

However, with urban expansion and lack of modern conservation measures, the traditional water system began to deteriorate. Over time, **Gundolav Lake became severely polluted** due to:

- Discharge of **untreated domestic wastewater**
- Dumping of **solid waste into open drains and lake catchments**

- **Encroachment** on natural **drainage channels** and buffer zones

As a result, the city eventually shifted to sourcing water from the **Bisalpur Dam**, marking a departure from its self-sustained, localized water heritage. (Sakshi Patel, 2024)

Current Water System

Primary Water Source

The primary source of water supply for Kishangarh is the **Bisalpur Dam system**, located approximately **120 km away**. Currently, the city receives about **22.40 million liters per day (MLD)** of **treated surface water** from the **Bagera Filter Plant at Kekri**, which is part of the Bisalpur supply network.

The treated water is delivered to a **Clear Water Reservoir (CWR)** with a capacity of **21,400 kiloliters**, located at **Masaniya Balaji Headworks**. From this point, water is pumped to multiple service reservoirs situated at **Azad Nagar**, **Chamda Ghar**, and **two Housing Board locations**, which then distribute water to different parts of the city.

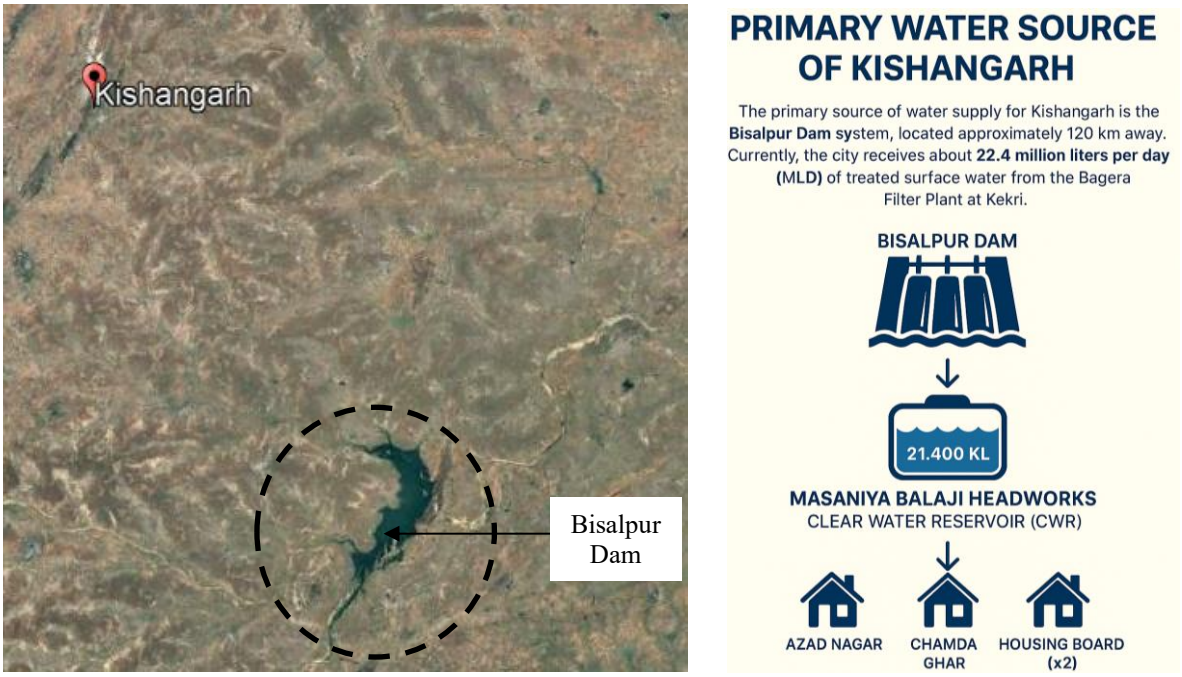
Kishangarh
Bisalpur Dam
PRIMARY WATER SOURCE OF KISHANGARH
The primary source of water supply for Kishangarh is the Bisalpur Dam system, located approximately 120 km away. Currently, the city receives about 22.4 million liters per day (MLD) of treated surface water from the Bagera Filter Plant at Kekri.
BISALPUR DAM
21.400 KL
MASANIYA BALAJI HEADWORKS
CLEAR WATER RESERVOIR (CWR)
AZAD NAGAR
CHAMDA GHAR
HOUSING BOARD (x2)

Figure 39 Location of Bisalpur dam

WATER SUPPLY RELATED DATA OF KISHANGARH

Major Source of Supply	Bisalpur Dam (Located 120 km away from Kishangarh)
Water Treatment Plant	Bagera Filter Plant, Kekri (Bisalpur System)
Treated Water Received	22.40MLD
Primary Clear Water Reservoir (CWR) Location	Masaniya Balaji Headworks
Primary CWR Capacity	21400kL
Intermediate CWR Locations	Azad Nagar, Chamda Ghar, Housing Board
ESR	25
Total ESR Capacity	15786KLD
Feeder Mains Length	~50km
Distribution Network Length	213 km
Distribution Zones	82
Per Capita Quantum of Water Supplied	90-100 LPCD
Total Water Connections	41732
Duration of Water Supply	Once in 48 Hrs

Table 8 Water supply related data of Kishangarh

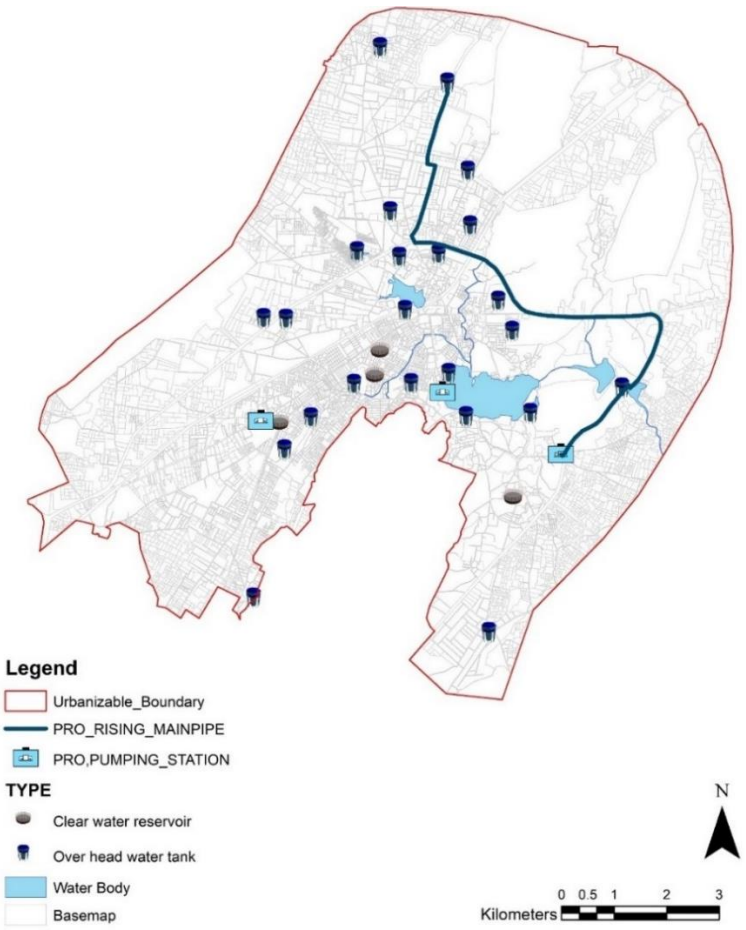

Figure 40 Existing Water Supply Plan

This map illustrates the existing and proposed water supply network, highlighting the critical infrastructure components that ensure potable water distribution across the urbanizable area.

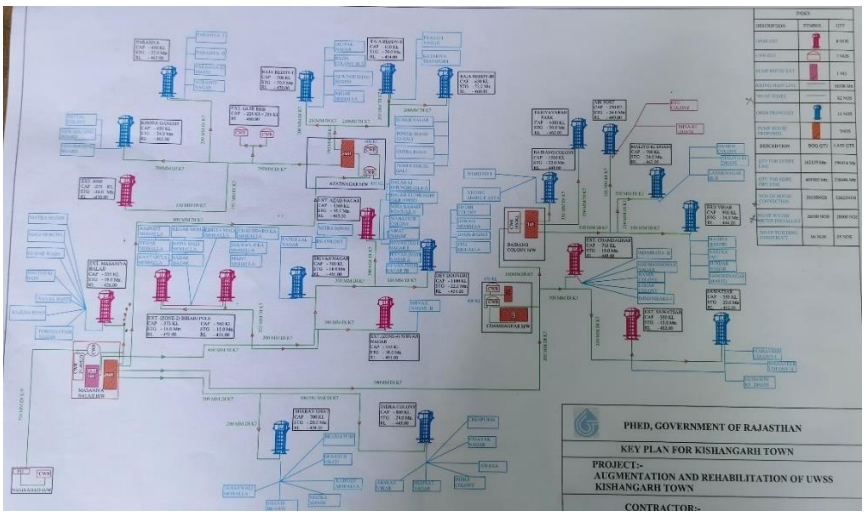

Figure 41 Key plan of Water supply system of Kishangarh

The image shown is a schematic key plan for the Urban Water Supply Scheme (UWSS) of Kishangarh Town, prepared by the Public Health Engineering Department (PHED), Government of Rajasthan.

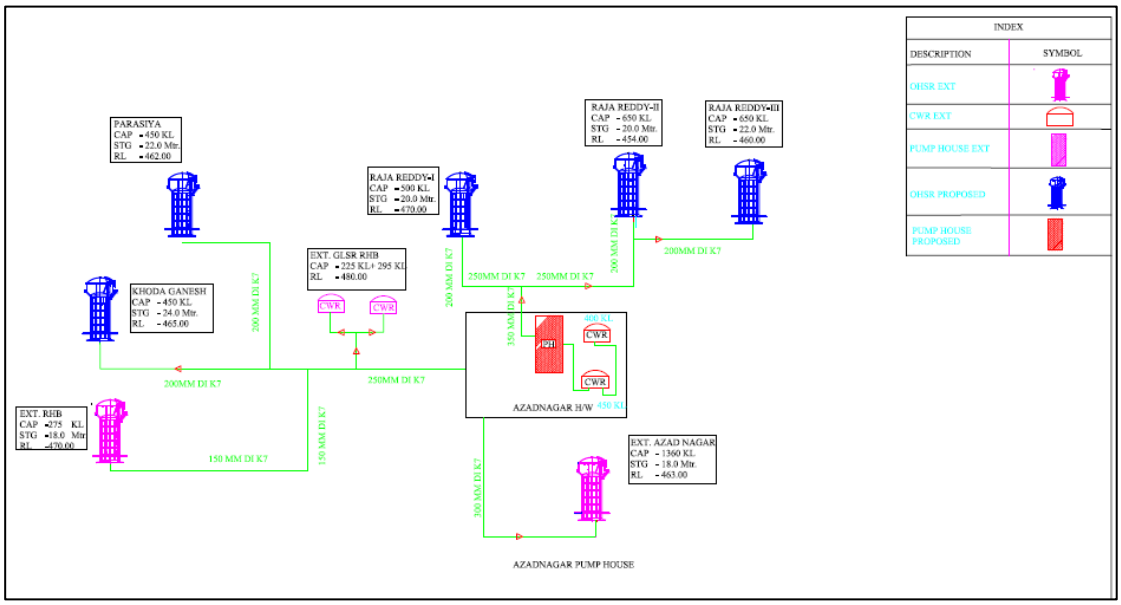

Figure 42 Supply plan of Azad nagar pump house

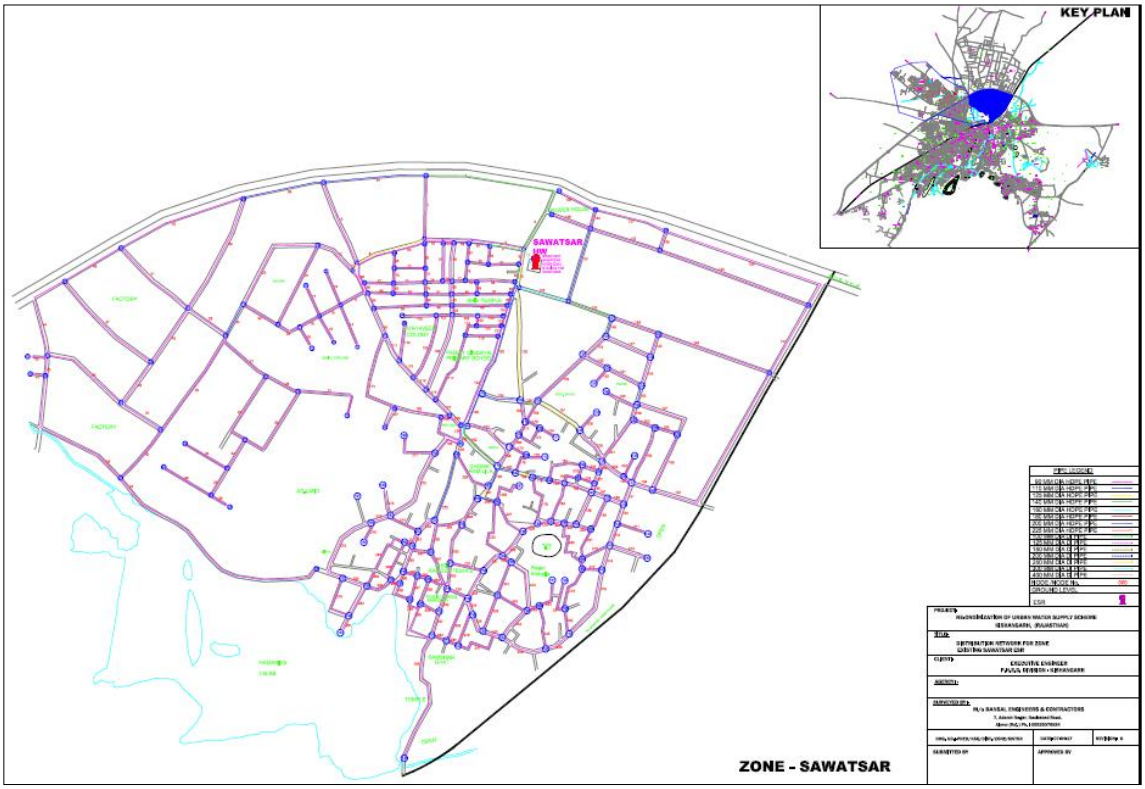

Table 9 Detailed Water supply plan of Zone Sawatsar

KISHANGAHR EXT PUMP & MACHINRY DETAILS										
SL NO	UMP HOUSE NAM	PUMPING TO	NOS OF PUMP		FLOW		CAPACITY		HEAD (M)	PUMPING HOURS
			W	S	CUM/ HR	LPS	HP	KW		
1	MASANIYA BALAJI PUMP HOUSE	BAJRANG COLONY 1850 KL & CHAMDAGHAR	1	1	715		167	125	43	16
		AZAD NAGAR 830 KL CWR	1	1	460		150	110	53	20
		INDRA COLOY 800 KL & BHERAV GHAT	1	1	185		75	55	60	18
		BIHARI POLE OLD ESR 373 KL BIHARI POLE ESR 450 KL SHIVAJI NAGR ESR 700 KL SHIVAJI NAGAR ESR 515 KL DAK BANGLOW ESR 1100 KL	1	1	498		240	80	90	18
2	AZAD NAGAR PUMP HOUSE	RAJA REDDY I ESR 500 KL RAJA REDDY II ESR 650 KL RAJA REDDY III ESR 650 KL NEW HOUSING BRD ESR 250 KL BALAJI DOONGRI GLR 100 KL	1	1	262		100	75	60	18
		PARASIYA ESR 450 KL KHODA GANESH ESR 550 KL OLD HOUSING BRD GLR 270 KL	1	1	202		60	45	52	18
3	CHAMDAG HAR PUMP HOUSE	CHAMDAGHAR ESR 753 KL SAWATSAR OLD ESR 350 SAWATSAR 300	1	1	230		50	37	42	18
4	BAJRANG COLONY	BAJRANG COLONY ESR	1	1	132		22	30	36	12
		MALIO KI DHANI 700 KL BRIJ VIHAR ESR 900 KL AIRPORT 250	1	1	244		100	75	55	14
		RICCO ESR 1000	1	1	137		50	37	60	0

Figure 43 Pump and Machinery details

S.No	Name of existing ESR	Capacity in KLD	Staging in mtr.
1	Ricco ex.Esr	1000	20
2	Sanwatsar old ex.Esr	350	18
3	Sanwatsar old ex.Esr	300	18
4	Chamda ghar ex.Esr	753	18
5	Maliyo ki dhani ex.Esr	700	24
6	Braj bihar ex.Esr	900	24
7	Dak bangla ex.Esr	1100	15
8	Azad nagar old ex.Esr	1350	18
9	Raja reddy 2 ex.Esr	650	20
10	Shivaji nagar old ex.Esr	515	18
11	Indira colony ex.Esr	800	24
12	Bihari pole ex.Esr	373	18
13	Shivaji nagar new ex.Esr	700	18
14	Bihari pole ex.Esr	450	20
15	Bhairav ghat ex.Esr	700	20
16	Masaniya balaji ex.Esr	225	18

17	Raja reddy 3 ex.Esr	650	20
18	Pharasiya ex.Esr	450	22
19	Khoda ganesh ex.Esr	550	15
20	Old housing board ex glsr	270	
21	Raja reddy 1 ex.Esr	500	20
22	New housing board ex.Esr	250	18
23	Housing board 4 phase ex.Esr	1000	20
24	Bajrang colony ex.Esr	1000	22
25	Airport ex.Esr	250	24

Figure 44 Details of ESR (Elevated Service Reservoir)

Secondary Water source

Due to the limited frequency of municipal water supply—delivered once every two days—most residents in Kishangarh rely heavily on **groundwater** as a supplementary source. This water is typically accessed through **individual borewells** installed in households and housing colonies.

In addition to domestic usage, industries **in Kishangarh**, particularly the marble processing units, are also **significantly dependent on groundwater** to meet their operational water demands. This over-dependence poses a growing concern for groundwater sustainability in the region, especially given the semi-arid climate and limited natural recharge.

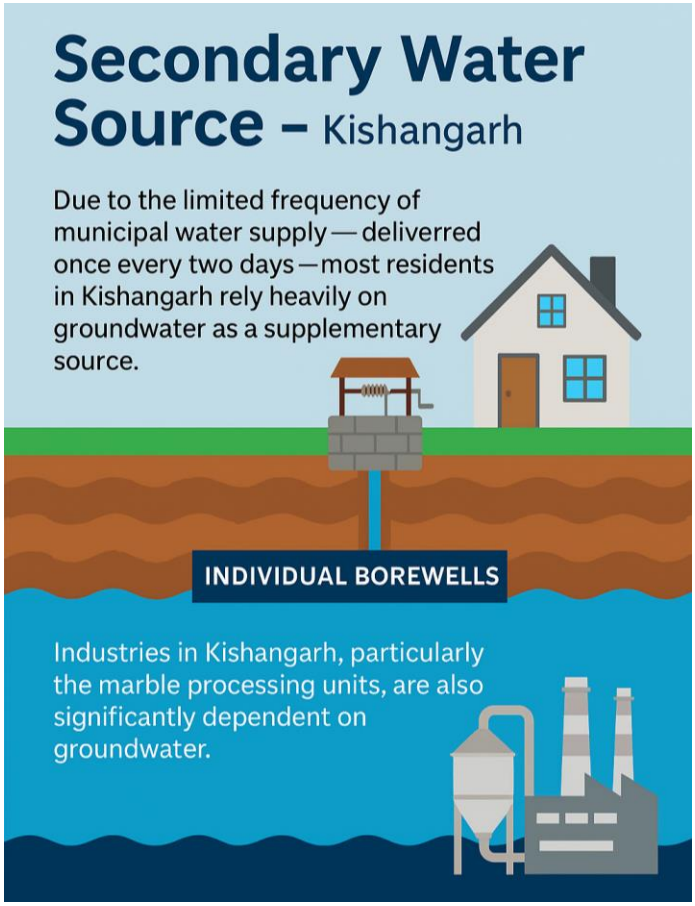
Secondary Water Source – Kishangarh
Due to the limited frequency of municipal water supply — deliverred once every two days — most residents in Kishangarh rely heavily on groundwater as a supplementary source.
INDIVIDUAL BOREWELLS
Industries in Kishangarh, particularly the marble processing units, are also significantly dependent on groundwater.

Figure 45 Secondary water source

3.9.2 Sewage:

The city has an open network of drains which carry wastewater as well as runoff/storm water. These drains run parallel to the roads. These open drains suffer from clogging due to solid

waste disposal and often lead to water-logging conditions

The city has two prominent drainage channels: One connecting Ransamand Lake to Gundolav and the other connecting Gundolav to Hameer Sagar. Most drains from the city ultimately empty in the Hameer Sagar Lake which flows to the Gundolav Lake.

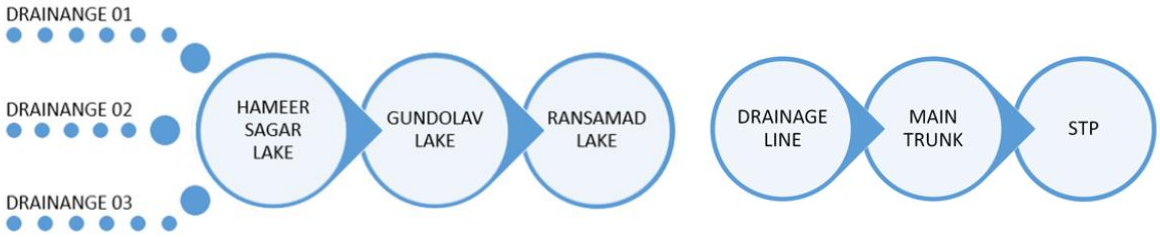

Figure 46 Flow of Drainage system of Kishangarh

Per capita Sewage contribution: The entire spent water of a community should normally contribute to the total flow in a sanitary sewer. However, the observed dry weather flow is usually slightly less than the per capita water consumption due to seepage in the ground, leakage etc. So Per capita sewage contribution **of 108 lpcd** is considered as 80% of water supply rate.

Condition of sewage Management: The sewer collecting system of the whole town is proposed to lie in two different zones. The sewage from houses will flow into laterals and branches and then into main sewers, which will carry sewage to proposed pumping stations. Eventually the collected sewage shall be pumped to the STP.

Sewage collecting system: There are individual soak pits to discharge sewage; some discharge is drained off at nearby nahla beside the main road. Due to increase in the use of water, they are being filled up soon and their maintenance becomes a nuisance.

Figure 47 Location of STP

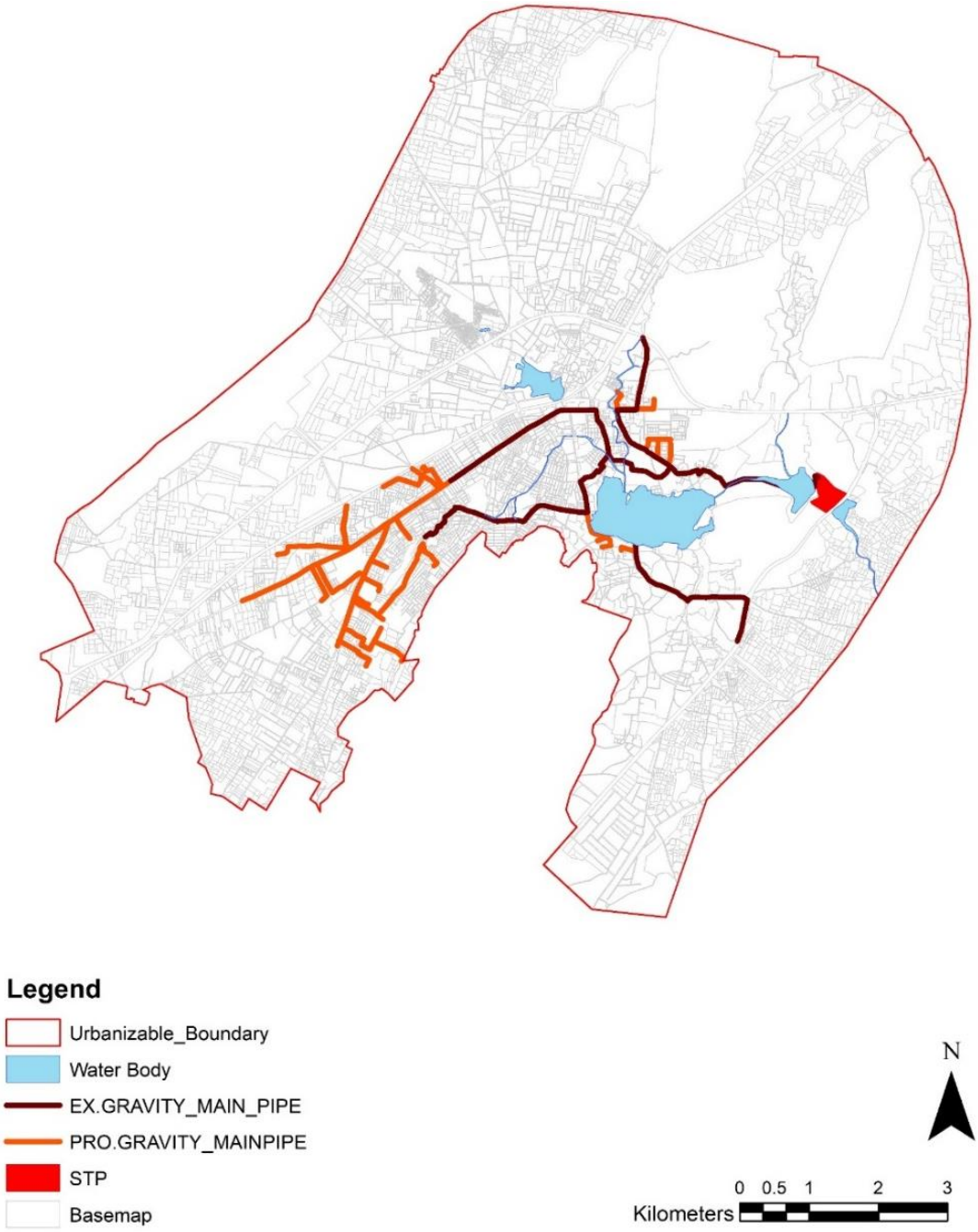

Figure 48 Existing Sanitation Plan

This map illustrates the existing and proposed sewerage network system for Kishangarh town, designed to manage and convey wastewater efficiently within the **urbanizable boundary.**

3.9.3 Waste Management

The city does not have Door to Door collection facility, and hence waste is dumped in open

areas. Despite the presence of free dumping at Marble slurry dump yard, marble waste is also disposed of along ponds. Many of the drainage channels to the ponds are getting blocked due to waste disposal and dump from marble industry. The waste from the city is dumped at the trenching ground, located 5 km away from the city along Silora Road, without any processing or scientific disposal. Improper collection and disposal have led to widespread dumping on lake banks, catchments, and roadside areas, causing visual blight and environmental degradation

Marble slurry from most marble processing units is brought to the dump yard which has 2 decant wells which settle the solid particles and the slurry waste finds its way into the water bodies and nallahs. The present dumping site is full and a new site is being developed adjacent to the old one. The RIICO industrial area generates 40 Lakh litre/day waste.

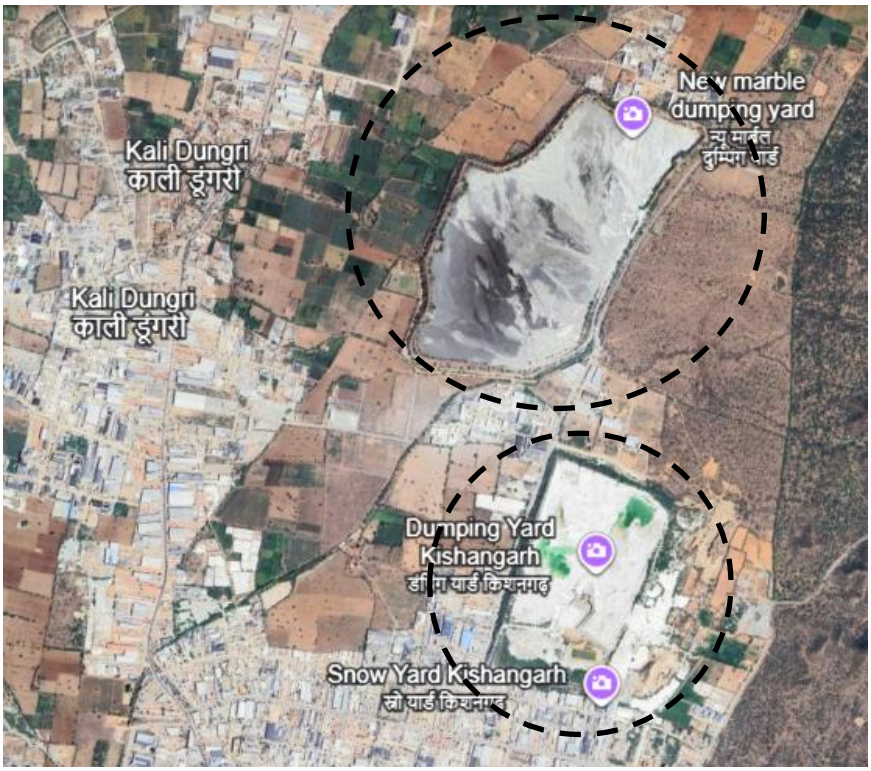

Figure 49 Location of Dumping yards

Dumping Yards

Two major dumping sites are located in the **northern part** of the city, situated near densely built-up residential zones. This placement raises significant environmental and public health concerns due to their close proximity to human settlements and potential for ground and

surface water contamination.

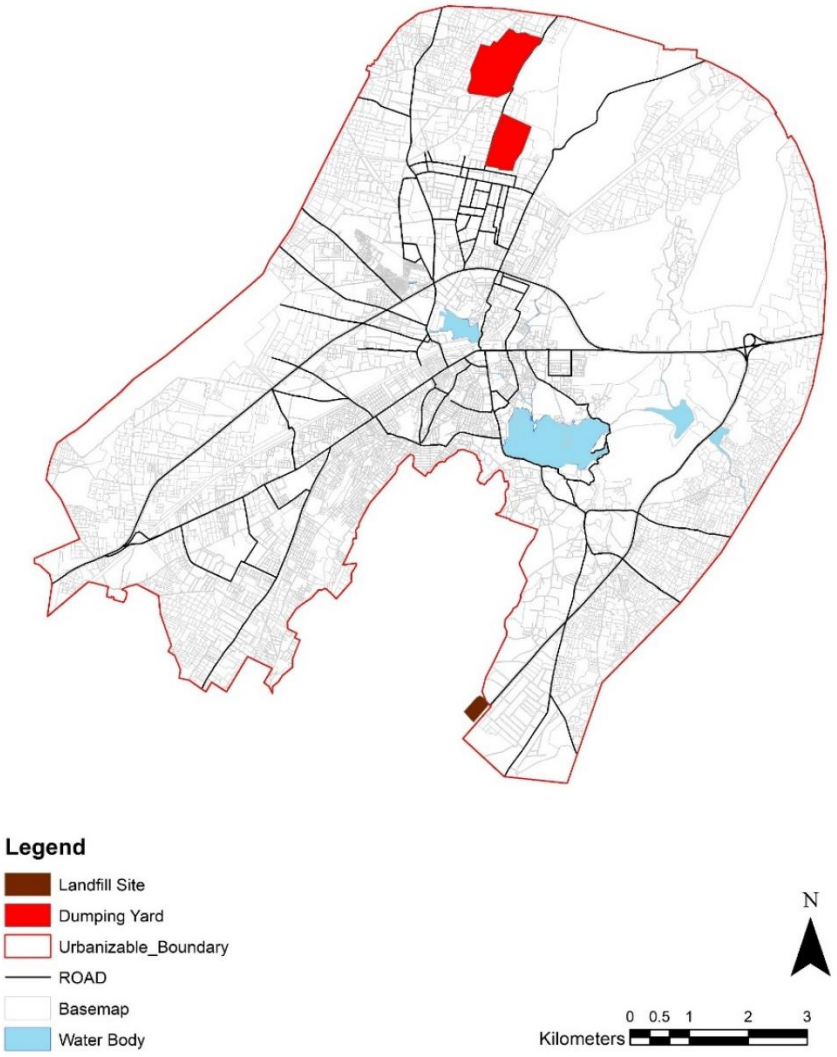

Figure 50 Location of Landfill site and Dumping Yard

Landfill Site

A designated landfill site is located in the **southern fringe** of the city, far from core residential areas. While this location is more suitable in terms of minimizing human exposure

YEAR	POPULATION	WASTE GENERATED
2011	154886	60 TON
2024	203994	91.79 TON

Figure 51 Waste generation in 2011 and 2024

GOVERNING AGENCY	MUNICIPALITY OF KISHANGARH
No. of Containers	2-3 Containers in one Ward
Capacity of Container	1.1 Meter cube
Collection frequency	Once in a Day

Figure 52 Waste management of Kishangarh

3.9 Cultural and Heritage Aspects

Figure 53 Image of Kishan Garh Fort, Phool Mahal Palace, Kishangarh Miniature Paintings, Roopangarh Fort, Gundalao Lake, Handicrafts and Marble Industry

Kishangarh's rich tapestry of **art, architecture, craft, and tradition** makes it a culturally significant urban center in Rajasthan. Its heritage—reflected in forts, palaces, paintings, and artisanal crafts—not only offers a deep sense of identity but also presents opportunities for cultural tourism and heritage conservation.

Kishangarh Fort

The majestic **Kishangarh Fort** stands as a symbol of the city's princely past. Built in the 17th

century, the fort showcases **Rajput military architecture** with intricately designed palaces, high ramparts, and ornate gateways. Once the seat of the ruling Rathore dynasty, it provides panoramic views of the surrounding landscape and Gundolav Lake.

Kishangarh School of Miniature Paintings

Kishangarh is home to the famous **Bani Thani** style of miniature painting—celebrated for its ethereal portrayal of Radha-Krishna with elongated eyes and stylized features. This unique art form emerged under the patronage of Raja Sawant Singh in the 18th century and remains a hallmark of Kishangarh's cultural identity. Local galleries and museums continue to preserve and promote this tradition.

Phool Mahal Palace

The elegant **Phool Mahal Palace**, located near Gundolav Lake, is adorned with **intricate floral frescoes**, delicate paintings, and Mughal-Rajput architecture. The palace, which served as a royal retreat, today stands as a testament to the opulence and refined taste of the region's rulers.

Roopangarh Fort

Situated about 25 km from Kishangarh, **Roopangarh Fort** was built in 1649 and served as a strategic outpost. It boasts massive stone fortifications, secret passageways, and well-preserved interiors. Now partly converted into a heritage hotel, it offers visitors a glimpse into regal lifestyles and historic military strategy.

Gundolav Lake

The historic **Gundolav Lake**, around which the city's early settlements and the fort were developed, once served as a primary source of water. Today, it offers a peaceful retreat and is surrounded by temples and ghats, making it an important part of Kishangarh's cultural and ecological landscape.

Handicrafts and Marble Heritage

Kishangarh is a prominent center for **marble processing**, housing hundreds of marble units and exporting stone worldwide. Alongside, it supports a thriving community of artisans engaged in **handicrafts**, including pottery, wooden toys, and traditional textiles. Local

markets are vibrant with the work of these skilled craftsmen, preserving age-old techniques.

Festivals and Cultural Events

Festivals such as **Gangaur**, **Teej**, and **Janmashtami** are celebrated with traditional music, dance, and vibrant processions. Art fairs and marble expos frequently draw national and international visitors, showcasing the cultural vibrancy of the city. (Journey, 2022)

Chapter -4

Analysis

4.1 Population Projection

Method	1991	2001	2011	2024	2031	2041
Arithmetic Increase Method	81,948	1,16,222	1,54,886	1,93,069	2,13,628	2,42,999
Geometric Increase Method	81,948	1,16,222	1,54,886	2,43,006	3,09,701	4,37,932
Incremental Increase Method	81,948	1,16,222	1,54,886	2,00,064	2,27,665	2,71,073
Logistic Curve Method	81,948	1,16,222	1,54,886	2,03,994	2,26,798	2,53,000
Fitting Curve Method	81,948	1,16,222	1,54,886	1,90,402	2,18,378	2,61,710

Table 10 Projected Population 2041

The population figures derived from the **Arithmetic Increase Method** show a consistent rise, as this method adds a fixed amount to the population each decade. In contrast, other methods—such as the **Geometric Increase Method**, **Incremental Increase Method**, and **Logistic Curve Method**—also show increasing trends but with varying rates.

For instance, the **Geometric Method** results in progressively larger increases, indicating **exponential growth**, where each decade's growth builds on the previous one. The **Incremental Increase Method**, however, reflects a **gradual decline** in the rate of increase, suggesting slowing growth over time. The **Logistic Curve Method** shows rapid growth initially, but the rate slows down as it approaches a saturation point, forming an **S-shaped (sigmoid) curve**—a pattern often seen in natural systems with limited resources.

Given that **Kishangarh's historical population trend resembles a logistic pattern**, and the **Logistic Method underestimates** the 2041 population based on recent growth, the **Fitting Curve Method** was selected. This method projects the 2041 population to be approximately **261,710**, offering a more realistic and balanced estimate.

Each method has specific contexts where it is most appropriate:

- The **Arithmetic Increase Method** is best for **large, established cities** where development is steady and mature, but it may underestimate growth in smaller or emerging towns.
- The **Geometric Method** is ideal for **new, rapidly growing industrial towns**, especially in early development stages, though it often overestimates long-term growth.
- The **Incremental Increase Method** is suitable for **medium-sized towns** with regular but moderate growth trends.
- The **Logistic Curve Method** is most effective where **growth is constrained by environmental or infrastructural limits**, as it accounts for a natural tapering off over time.

Ultimately, the **Fitting Curve Method** offers the most accurate projection for Kishangarh, aligning well with its growth trajectory and urban characteristics.

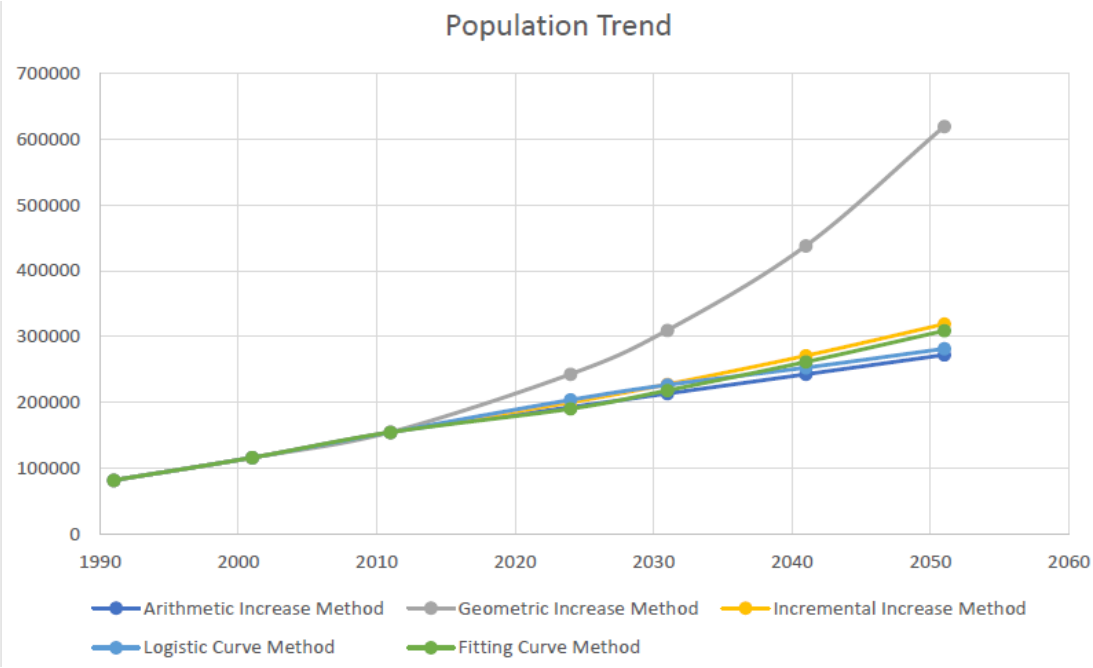

Figure 54 Population Trend (population Vs year)

The data indicates that the population figures projected using the **Arithmetic Increase Method** show a steady rise, as each decade adds a consistent number of people. In contrast, the **Geometric Increase Method** displays a rapidly accelerating growth, with each decade showing a significantly larger increase than the previous—indicating exponential growth.

With the **Incremental Increase Method**, the population continues to grow, but the rate of increase gradually declines over time. The **Logistic Curve Method** initially shows population growth, but this growth slows down in later years, forming a typical sigmoid pattern—a trend often seen in natural systems approaching their saturation point.

Considering Kishangarh's historical population pattern also aligns closely with a logistic growth model (with gradual stabilization over time), the **Fitting Curve Method** has been chosen for future projections. This method offers a balanced estimate and projects the population to be **2,61,710 in 2041** reflecting a realistic and moderate growth outlook.

4.2 Land use Analysis

Land use over the years

Proposed Land use Map of 1989: The Master plan shows that the Industrial zones (marked in purple stripes) mostly concentrated in Roopnagar, northeast and are located very close to large **water bodies** (blue areas) such as Hameer Talab, Gundolav Lake and nearby ponds leading to:

- **Marble slurry and effluent** entering natural water systems
- Deterioration of water quality and **groundwater contamination**.

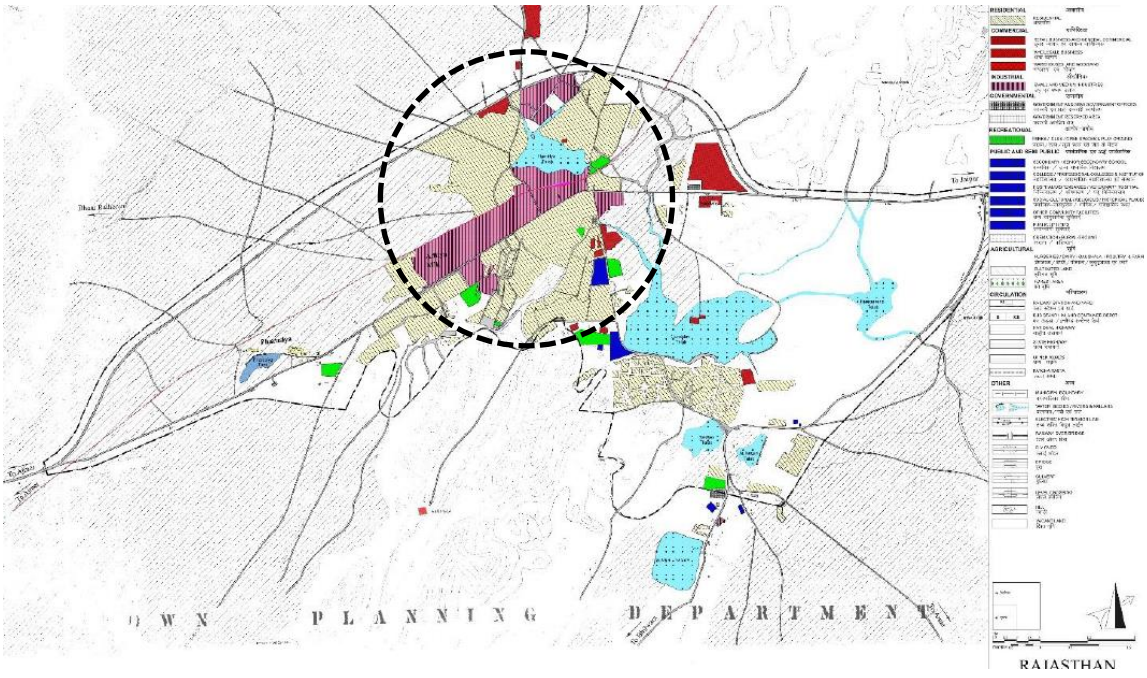

Figure 55 Proposed Master plan of 1989

Proposed Land use Map of 2011: Major industrial zones (marked with purple diagonal lines) expanded in north, west & south are still closely interwoven with residential areas (cream/yellow shade) and are near waterbodies. It attempts to correct past Masterplan flaws from the 2011 map by introducing structured zones, separating conflicting land uses, and improving public infrastructure layouts. However, industrial-environmental conflicts are still there.

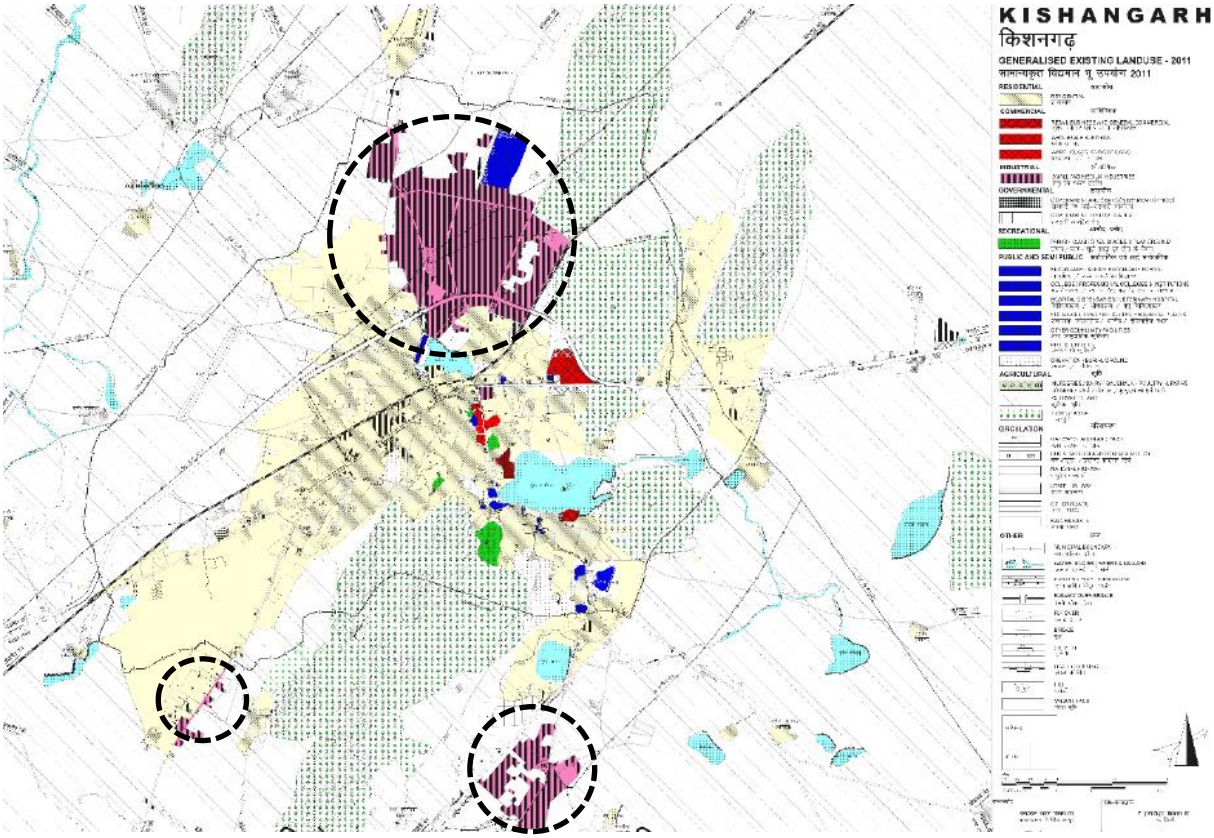

Figure 56 Proposed Master plan of 2011

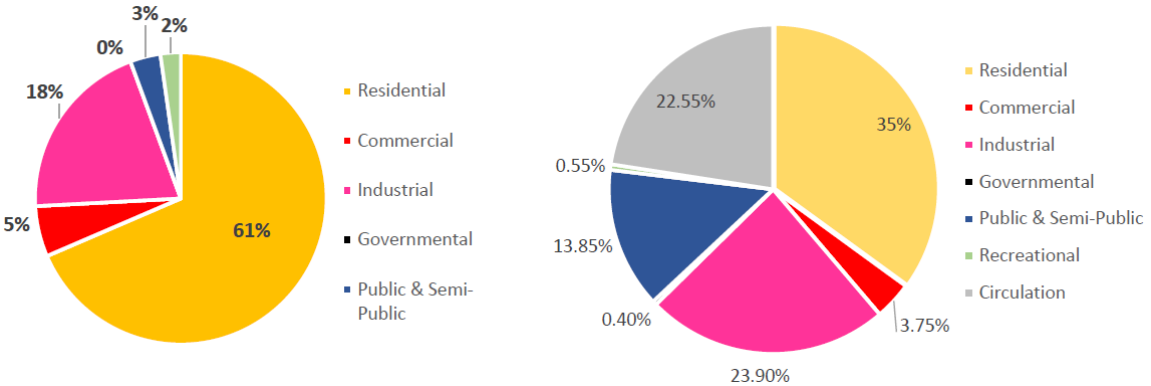

Figure 57 Area percent chart of Proposed Land uses of 1989 and 2011

Existing Land use plan of 2025: The industrial zones (marked in purple) continue to be situated in close proximity to major water bodies and have increased in area from 2011 land use plan. One of the major concerns is the absence of adequate buffer zones separating industrial areas from nearby residential and agricultural zones. Rather than being contained or relocated, industrial development is expanding, further encroaching into surrounding areas.

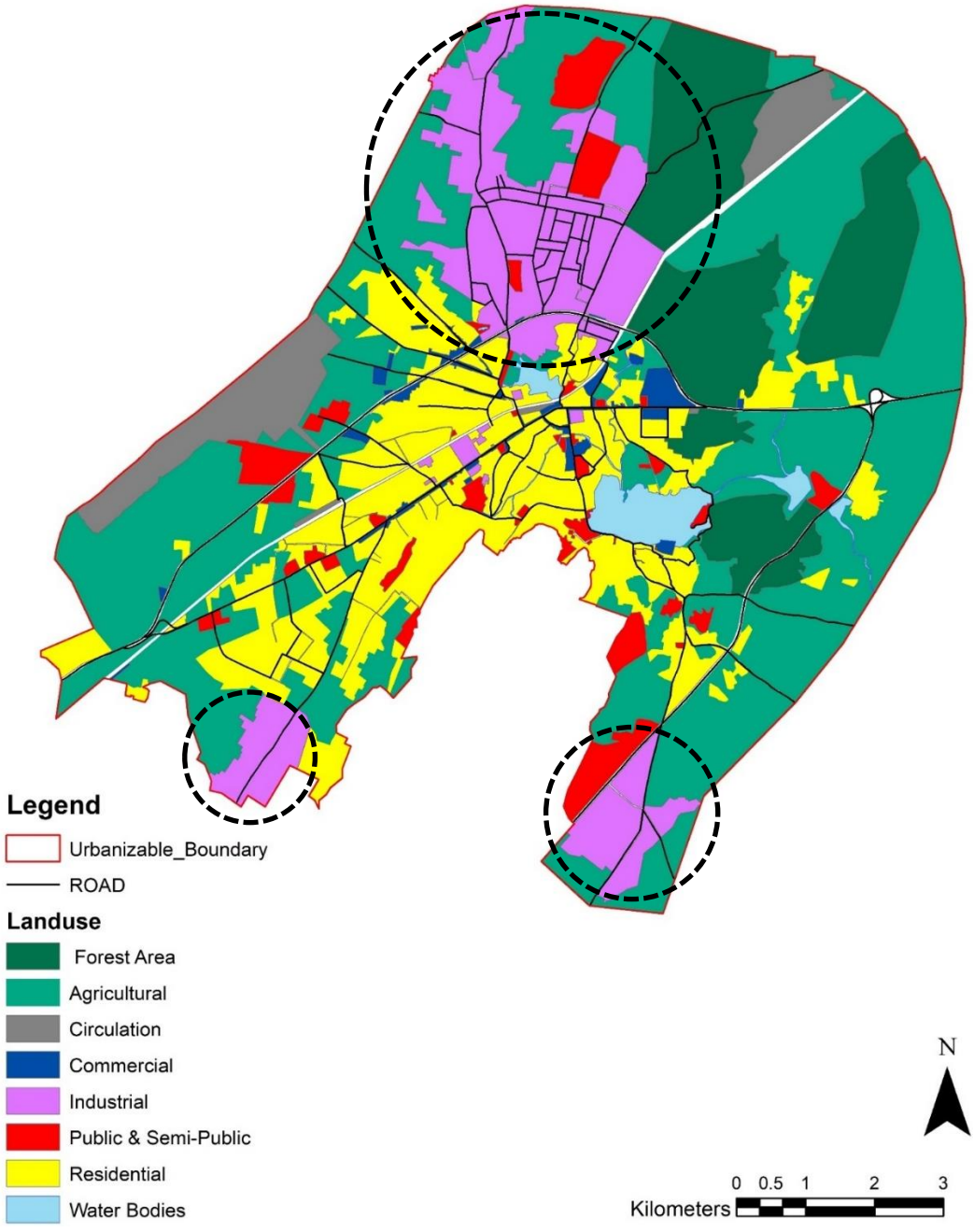

Figure 58 Existing land use plan of 2025

Additionally, water bodies located within the urbanizable boundary are increasingly surrounded by high-density land uses, particularly residential and commercial developments. This has led to challenges such as urban runoff, indiscriminate solid waste disposal, and the absence of a dedicated stormwater drainage system — all of which are contributing significantly to the degradation of these important surface water resources.

Proposed Land use plan 2031: The proposed masterplan fails to address the critical concerns highlighted regarding the water bodies, industrial zones, and residential areas. It overlooks the need for protective buffer zones around water bodies, continues to allow industrial expansion near ecologically sensitive areas, and does not adequately segregate residential areas from polluting land uses.

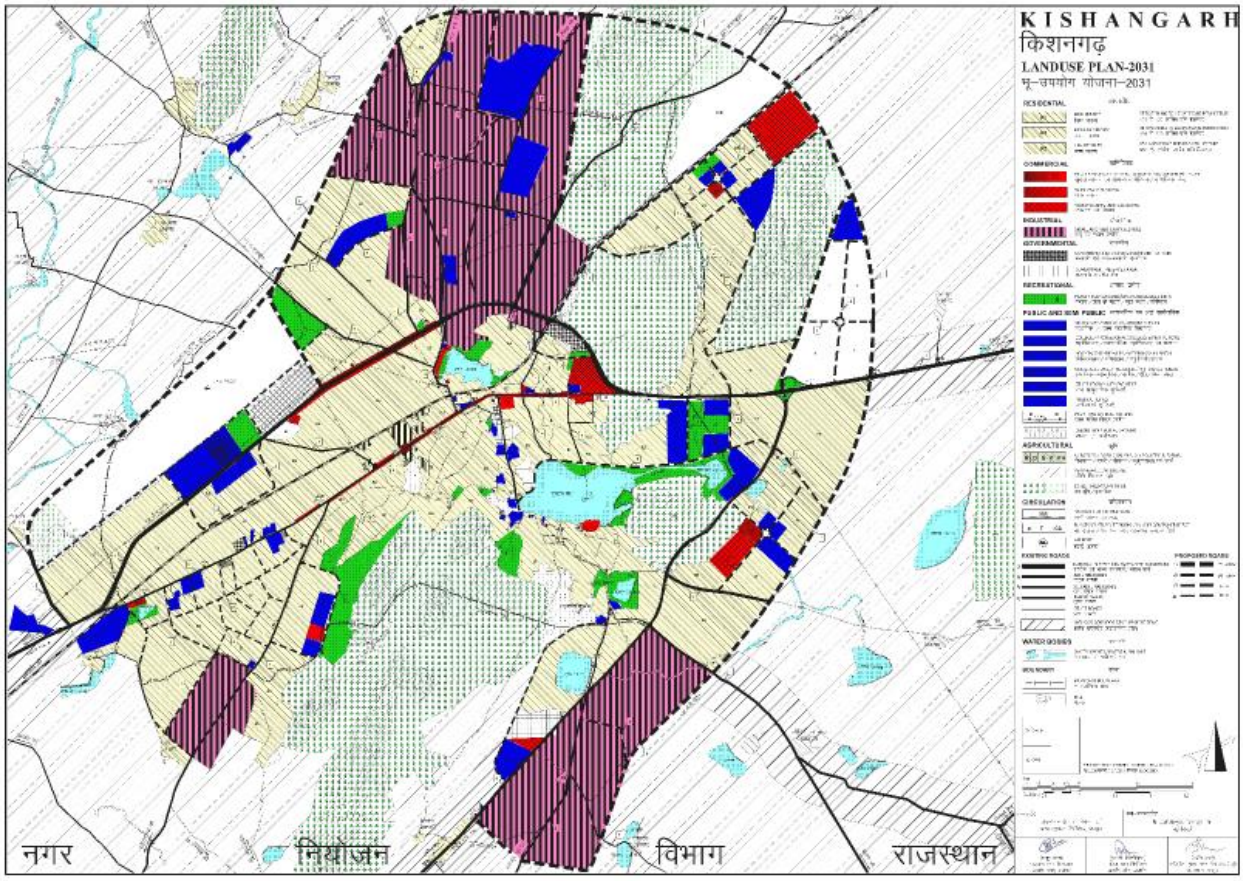

Figure 59 Proposed land use of 2031

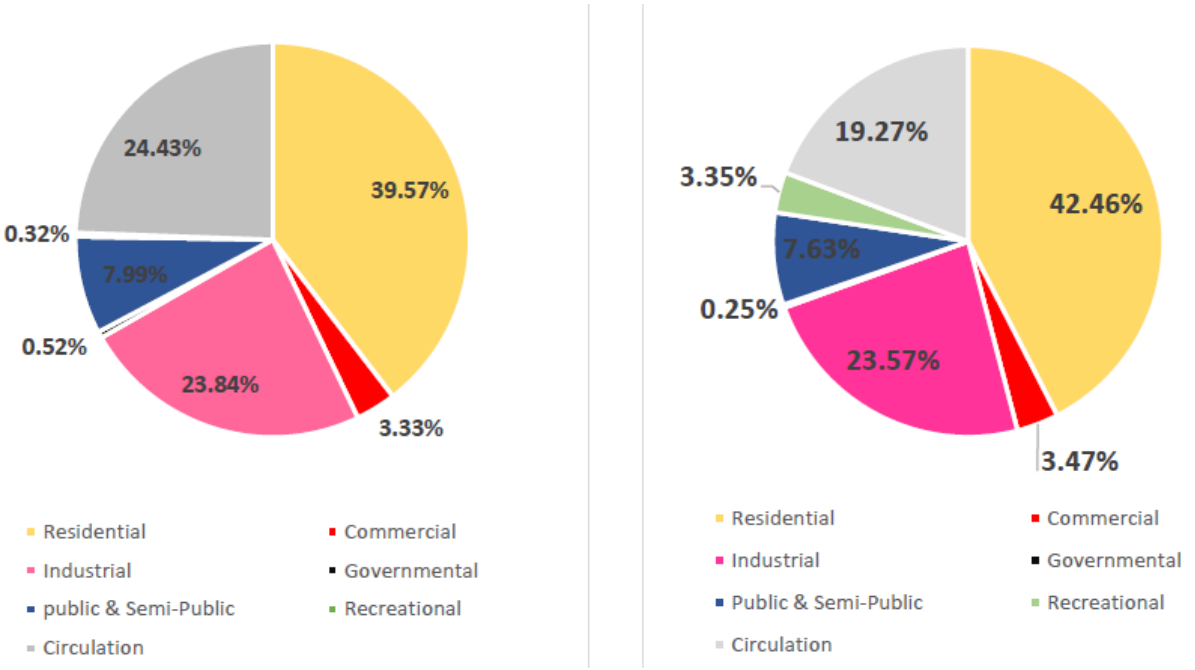

Figure 60Landuse Distribution of Year 2025 & 2031

Sl. No.	Land use Category	Percentage of Developable Area
1	Residential	20-25
2	Commercial	3-4
3	Industrial	30-35
4	Public and Semi-Public	6 -8
5	Recreational	12-15
6	Transport and Communication (including logistics)	10-12
7	Water bodies & Special areas	Balance
	Total	**100**

Note: The above landuse distribution is indicative, and may vary as per the size of SEZ, industrial town, cluster development.

Figure 61 Proposed Land use structure for industrial towns according to URDPFI guidelines

As Kishangarh functions as an industrial town, industrial land use has become a dominant component of its spatial layout. Currently accounting for approximately **24%**, this share is projected to rise to **35%**, driven by the continuous expansion of marble industries. However, this rapid industrial growth has emerged as a key factor contributing to the **degradation of local water bodies**, due to unregulated discharge, lack of buffers, and land use encroachments.

Despite being an industrial town, **there are specific environmental regulations and planning norms** developed by CPCB and state government that must be adhered to ensure that industrial growth does not compromise the city's ecological balance and long-term livability. (India, 2015)

As per the CPCB 2025 sector categorization report:

Cutting, sizing, and polishing of marble, granite, and other stones is listed under:

Serial No. 166,

Pollution Index (PI): 40.5,

Category: Green,

Concerned Division: IPC-V

This Means:

Industries with a Pollution Index (PI) between 21 to 40 falls under the Green Category, indicating low pollution potential.

Therefore, marble processing units — without mining and within environmental norms — are now officially classified under Green Category by CPCB. (Board C. P., Classification of Sectors into Red, Orange,Green, White and Blue Categories , January 2025)

S. No.	Sector	W1	W2	W3	PI_W	A1	A2	A3	PI_A	H1	H2	PI_H	Pollution Index (PI)	Category	Remarks	Concerned Division
165	**Spice** grinding	0	0	0	**0**	0	30	0	**30**	0	0	**0**	30	Green		IPC-V
166	Cutting, **Sizing** and polishing of marble, granite and other stones	10	0	20	**30**	0	30	0	**30**	0	0	**0**	40.5	Green		IPC-V
167	Manufacturing of **Solar** module/ non-conventional energy apparatus	0	0	0	**0**	0	0	0	**0**	0	0	**0**	0	White		IPC-V

Figure 62 Classification of Marble industries according CPCB

According to the Rajasthan State Pollution Control Board's 2020 report:

activities such as cutting, sizing, and polishing of marble, granite, and other stones are classified under the orange category of industries.

Category : Orange

S. No.	Industry Sector
1	Aluminum and copper extraction from scarp using oil fired furnace
2	Any industry/ industrial activity/ process/ operation/ facility which is not covered in Red or Green category but having coal fired boiler with steam generation capacity upto 5 T/hr
3	Assembly and charging of acid lead battery / Dry cell battery (more than 10 battery per day)
4	Automobile servicing, repairing and painting (with washing)
5	Ayurvedic and Homeopathic medicine (with Boiler)
6	Bakery/ Confectionery/ Sweets production (with production capacity ≥ 1tpd with oil, gas or electrical oven)
7	Bio Fuel (with boiler and/or using organic solvents)
8	Brickfields (excluding fly ash brick manufacturing using lime process)
9	Building and construction project ≥ 20000 Sq. M township and area devepoment project 5 hectare and more/ dwelling units 50 and more
10	Candy Manufacturing - Large & Medium Scale
11	Cashew nut processing
12	Ceramic, Refractories
13	CFL, tube light bulb and so on
14	Chanachur and ladoo from puffed and beaten rice(muri and chira)
15	Coal Washeries
16	Coated electrode manufacturing
17	Coffee seed processing
18	Coke briquetting (except sun-drying)
19	Compact disc, computer floppy & cassette manufacturing
20	Cotton ginning & processing (Large and Medium Scale units)
21	Cutting, sizing and polishing of marble, granite, kota stone and other stones (Except edge cutting & Chowkhat making)

Figure 63 Classification of Marble industries according RSPCB

Also, if there is no proper slurry management at the unit level or centralized treatment, and slurry is dumped openly (as in Kishangarh), then these units DO NOT qualify as Green Category—even if CPCB's table says so.

Board	Classification	Notes
CPCB	Green	Based on national-level PI calculation (Pollution Index = 40.5)
RSPCB	Orange	State-level classification considering local environmental conditions

Table 11Category according to CPCB and RSPCB

So, the marble industries in Rajasthan are considered in orange category.

Norms for industries in orange category according to Ministry of environment, forest and climate change notification 2025- Chapter-3-Critera for establishment of Industrial plant are: While establishing an industrial plant, the following minimum distance shall be maintained, namely:

(a) from the nearest boundary of surface water body (flood plain/ HFL/Red line) as per the revenue records in case of industrial plant of-

(i) red category, beyond five hundred meters;

(ii) orange category,

(A) with effluent generation, beyond seventy-five meters;
(B) without effluent generation, beyond thirty meters;

(iii) green category, beyond thirty meters;

(b) from the settlement, educational institute, worship place, archaeological monuments, national park, reserve forest, heritage site, in case of industrial plant of-

(i) red category, beyond five hundred meters;

(ii) orange category, beyond two hundred meters;

(iii) green category, beyond one hundred meters.

(c) The State Board shall ensure that other laws, rules, and regulations, and notifications are complied with by the industrial plant.

(d) The natural or storm drain passing through the location of industrial plant shall not be disturbed.

Figure 64 Norms for industries in orange category Ministry of environment, forest and climate change notification

Pollution caused by Marble Industries

Marble Processing and Slurry Generation:

Processing involves receiving rough blocks (15-20 MT), dressing them, and then cutting them into thinner sheets (typically 15-20 mm) using gangsaw machines with diamond-studded saws.

Figure 65 Rough and non- uniform marble blocks received in Gantry Yard

The cutting process, which uses continuous water sprinkling as a coolant, generates wet marble dust. For every 25mm of block thickness, approximately 5mm turns into powder.

Figure 66 Processing of Marble Block through Gangsaw machine

This wet dust is collected in sedimentation tanks where the solid particles settle, and the water is often reused.

Figure 67 Sedimentation tanks used for settlement of semi solid marble slurry

Approximately 20-25% of the processed marble block's weight becomes marble slurry, which contains 35-45% water. An additional 5-7% of the processed block becomes polishing waste during grinding and polishing. (Board C. P., Guidelines for Management and Handling of Marble Slurry generated from Marble Processing Plants in Rajasthan)

Figure 68 Marble slurry dumping at Kishangarh dumping site

Characteristics	Properties
Form	Fine powder
Color	Off white
Shape	Angular
Particle Size (µm)	<45-300
Particle Density (gm/cm^3)	2.70-3.00
Bulk Density (gm/cm^3)	0.9-1.4
Loss on Ignition	23-35%
Moisture (%)	5-20%
Mineralogy	Calcitic & Dolomitic lime

Source: M/s ACC Cement, Lakheri, Kota and NCBM, New Delhi

Figure 69 Physical characteristics of Marble Slurry

Effect of marble industry waste on Kishangarh

Waste byproduct from marble processing, known as **marble slurry**, which contains about **60% water**, is dumped across a 200-acre site. Kishangarh Marble Udhyog Vikas Samiti has developed a dumping site (Phase-I) in year **2005-06** in **about 322 bigha area of 30-35 feets depth.** The decanting wells are also provided and decanted water is recycled to gangsaw units. Dumping site is designed to take care of marble slurry, generated from processing houses with the life of **05 years**. Another dumping site is also developed in Phase-II in 2009 of area **532 bigha area** (332.5 acre) near to earlier dumping site to dump the generated marble slurry

The dumping site resembles a snow-covered field due to the buildup of **calcium carbonate**.

Figure 70 View of Dumping site

Effects-

- **Water Pollution:**
  A study by the Central University of Rajasthan found that water sources within a 6 km radius of the dumping site have Total Dissolved Solids (TDS) levels up to 10 times higher than safe limits.
- **Soil Degradation:**
  Fine marble particles (less than 75 micrometres) settle on farmlands and mix with irrigation water, reducing soil fertility and harming crop yields.
- **Contaminated Groundwater:**
  Groundwater in the area is unsafe for drinking or irrigation due to the infiltration of fine marble particles.
- **Air Pollution and Health Issues**:
  Constant exposure to marble dust causes **respiratory issues**, including chronic cough. Local communities have reported a rise in **pollution-related illnesses**.

4.3 Water Supply Analysis

Current Water demand calculation (Domestic + institutional + minor commercial uses):

Total Population of 2025= **190,402**

Per Capita Water demand= 135lpcd

Current Water Supply=22.4MLD - System losses (non-revenue water+ leakages) (ICLEI – Local Governments for Sustainability, 2017)

= 22.4 - 32%

=15.23 MLD

$$\text{Total Demand (MLD)} = \frac{\text{Population} \times \text{Per Capita Demand}}{1,000,000}$$

=(190402 X 135)/1,000,000

= **25.7 MLD**

Current Water deficit = Current demand- Current Supply

= 25.7- 15.23 MLD

= 10.5 MLD

The city is 10.5 MLD deficit in 2025.

Estimated Water demand calculation for 2041 (Domestic + institutional + minor commercial uses):

Population projected for 2041=2,61,710

$$\text{Total Demand (MLD)} = \frac{\text{Population} \times \text{Per Capita Demand}}{1,000,000}$$

= (2,61,710 X 135)/1,000,000

= 35.33MLD

35.33 MLD for domestic, institutional, and minor commercial uses.

4.4 Groundwater Quality Assessment

Parameter	Value
Annual Rainfall	684.3 mm (92% during monsoon season)
Runoff	474.2 mm
Recharge	32.6 mm
Runoff Coefficient	0.6
Recharge Coefficient	0.04 Very Low
Total Precipitation Volume	892.8 MCM
Total Recharge Volume	42.5 MCM/year

Table 12 Data related to groundwater

Most rainfall runs off the land; **only 4% infiltrates** to recharge groundwater — showing extreme **quantitative vulnerability**. (Board C. G., 217)

Parameter	Observed Range	BIS Permissible Limit	Issues Identified
TDS	520–755 mg/L	500 mg/L (desirable)	High salinity levels in 10 out of 16 sites
Hardness	255–310.5 mg/L	300 mg/L	Classified as *very hard* at several sites
Na^+	Up to 480 ppm	–	Very high in multiple sites
K^+	Up to 1210 ppm	–	Very high in most sites
Copper	0.73–1.62 mg/L	0.05 mg/L	16x above permissible limit at some sites
Fluoride	0.8–3.2 mg/L	1.0–1.5 mg/L	Exceeds limits in 11 out of 16 sites

Arsenic, Cr, Cd	Within limits	(BIS standards)	within safe limits

Figure 71 Table showing limits and pollution level

Table 4 The analyzed values of the pH, EC, salinity, alkalinity, sodium and potassium for collected groundwater in the study area

S. no.	Sampling site	pH (standard value 6.5–9.2)	EC (0–800 uS/cm)	Salinity (200–600 mg/L)	Alkalinity (10–500 mg/L)	Hardness (300)	Electrolyte Na^+(ppm) (300 ppm)	Electrolyte K^+ (300 ppm)
1	Sinodiya	8.3	420	**755**	95	296	**480**	300
2	Nosal	7.2	480	**755**	125	295	**450**	**948**
3	Jajota	6.8	485	**720**	185	**310.5**	**420**	**1210**
4	Roopangarh	7.1	485	**680**	95	**302**	246	**370**
5	Amarpura	6.9	520	**712**	112	**305**	268	**420**
6	Kucheel	6.8	485	**680**	155	**310.5**	282	**370**
7	Thal	7.2	480	600	120	296	265	**413**
8	Tyod	7.2	465	580	125	295	272	**462**
9	Silora	6.8	420	**620**	95	295	251	**393**
10	Tiloniya	6.9	455	580	95.5	**310**	253	**443**
11	CURAJ	7.2	420	520	45.5	290	264	**412**
12	Arain	7.6	480	580	85.5	255	253	**382**
13	Ankauriya	7.5	480	**670**	95.5	**310**	**410**	**930**
14	Trihari	7.6	485	**685**	90	**310**.5	245	**360**
15	Bhambholao	6.8	520	**650**	95	285	250	**399**
16	Kishangarh Urban	7.2	560	580	120	**310**.5	240	**441**

Bold values represent the values higher than permissible/maximum limit of parameters as per BIS standards for drinking water

Figure 72 Pollution level at different sites

Table 5 The analyzed values of the arsenic, chromium, cadmium, copper, iron and fluoride of the study area

Sr. no.	Sampling site	Arsenic (0.05 mg/L)	Chromium (0.05 mg/L)	Cadmium (0.01 mg/L)	Copper (0.05 mg/L)	Fluoride (1.2 mg/L)	Iron (0.3 mg/L)
1	Sinodiya	0.04	0.01	0.006	**0.96**	**2.6**	0.23
2	Nosal	0.03	0.01	0.004	**0.86**	**2.9**	0.25
3	Jajota	0.02	0.01	0.006	**0.93**	**3.2**	0.27
4	Roopangarh	0.03	0.01	0.001	**0.73**	**2.3**	0.26
5	Amarpura	0.02	0.01	0.01	**0.85**	**1.9**	0.23
6	Kucheel	0.05	0.01	0.007	**0.93**	**2.3**	0.19
7	Thal	0.03	0.01	0.01	**0.86**	0.9	0.15
8	Tyod	0.03	0.01	0.01	**1.23**	**1.8**	0.23
9	Silora	0.04	0.02	0.01	**0.96**	**1.2**	0.26
10	Tiloniya	0.02	0.01	0.005	**0.98**	0.8	0.25
11	CURAJ	0.05	0.01	0.006	**0.98**	0.8	0.19
12	Arain	0.02	0.02	0.01	**1.62**	0.9	0.18
13	Ankauriya	0.04	0.01	0.01	**1.52**	**1.2**	0.23
14	TRihari	0.04	0.01	**0.13**	**0.92**	**2.3**	0.26
15	Bhambholao	0.03	0.02	0.01	**0.86**	**1.9**	0.23
16	Kishangarh Urban Area	0.02	0.02	0.01	**1.23**	0.9	0.23

Bold values represent the values higher than permissible/maximum limit of parameters as per BIS standards for drinking water

Figure 73 Pollution level at different sites

Copper and fluoride are the most problematic contaminants in Kishangarh's groundwater, largely due to **geogenic sources** (natural mineral deposits) and **industrial activity** (especially marble processing)

Kishangarh faces **both quantitative and qualitative** groundwater vulnerability. Groundwater recharge is minimal, and contamination is widespread due to:

- Over-extraction
- Industrial effluents
- Weathering of mineral-rich rocks

4.5 Surface water bodies Analysis

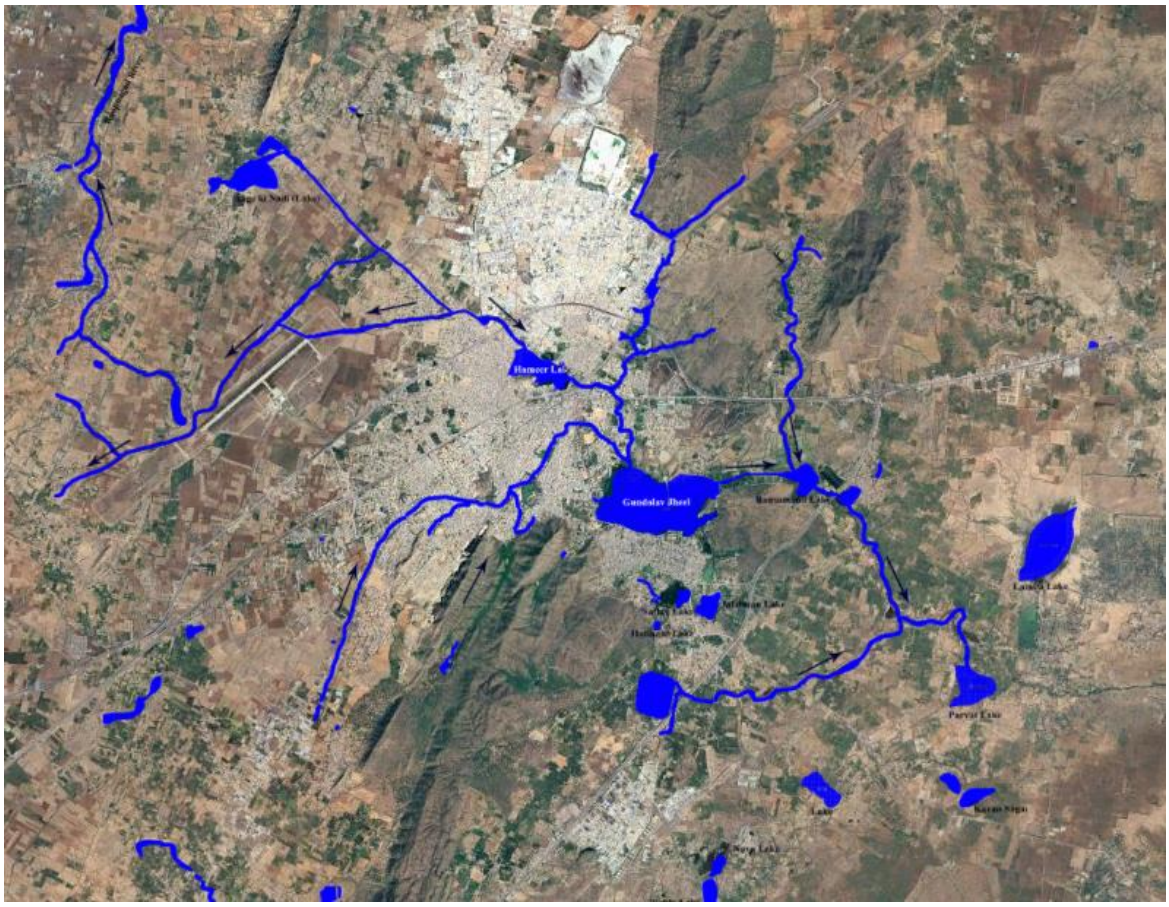

Figure 74Original Water system overlayed on Satellite imagery

Disruption in the original catchment area and Water system

Fragmentation Observed:

The **red lines in the map** represent **broken or obstructed connections** in the traditional water flow system. These are encroached upon by urban development, road construction, altered or blocked by land use changes, especially due to **residential expansion** and **industrial spread**.

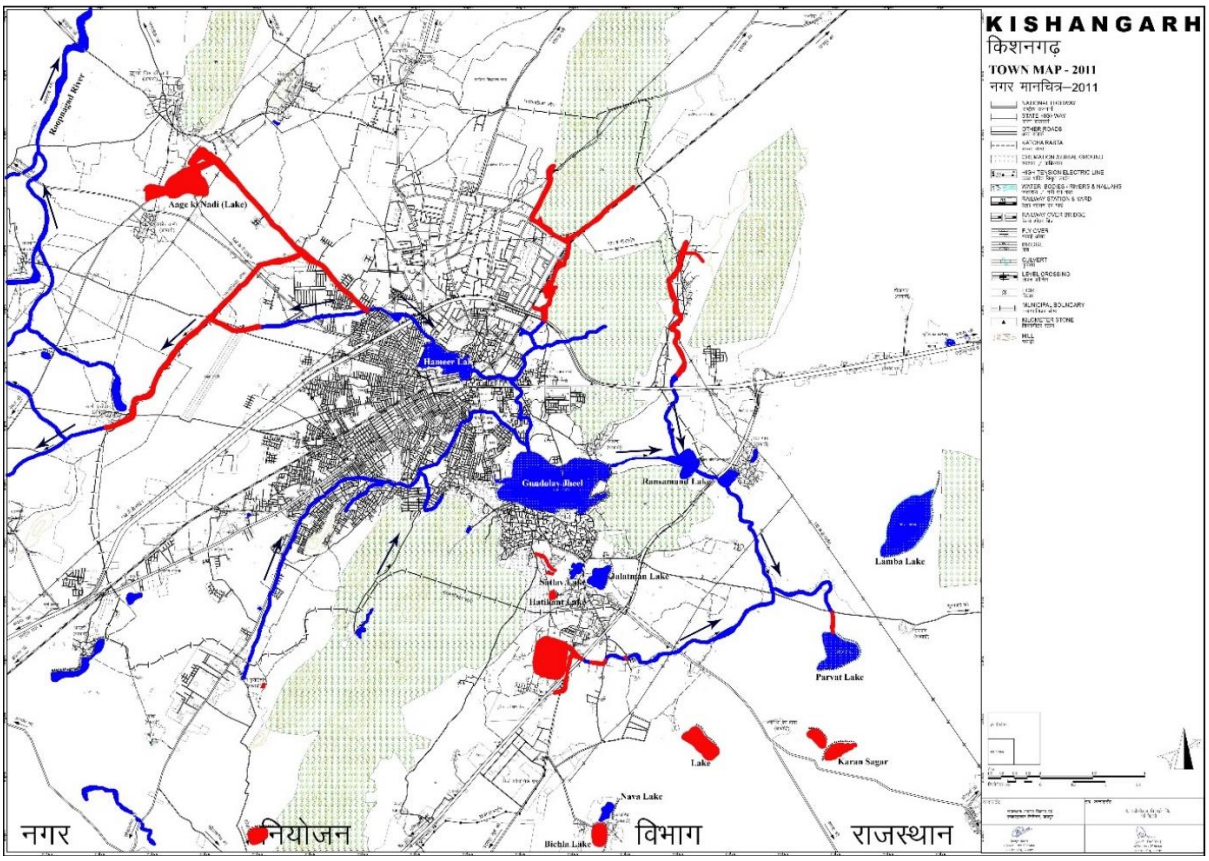

Figure 75 Map showing lost network and waterbodies of the traditional water system

From the 2011 Town Map and current land use key observations are:

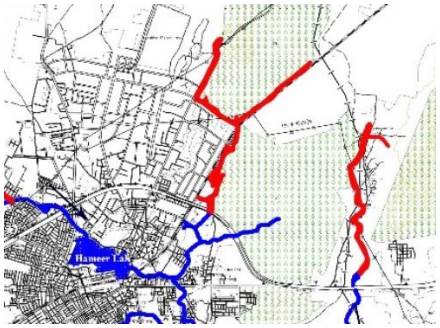

Figure 76 Images of Spruit from the site

The **Aage ki Nadi Lake** has been lost, as the area it once occupied has now been converted into **agricultural land**. As a result, the **canal that once fed the lake has dried up**, leading to a break in the network.

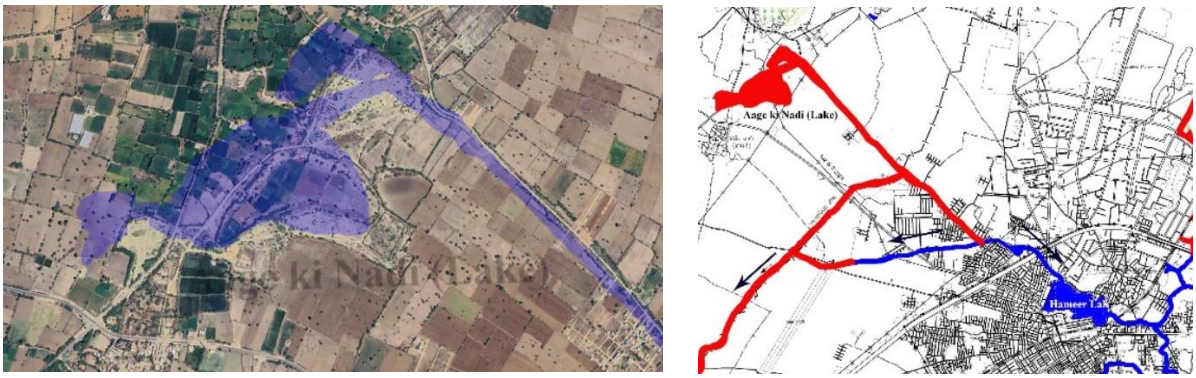

Figure 77 Satellite Image of Aage ki nadi lake from the site

Hameer Lake to Gundolav Talav to Ransamand lake –

Although the natural flow of water still exists, it has become heavily polluted due to increasing urbanization pressures, including the discharge of untreated sewage into canals and the lack of an effective solid waste management system.

Figure 78 Image of Hammer talab ki Aaw and Gundolav overflow point from the site

Jalatman lake, Bichala lake, Jalatman lake and some more waterbodies are lost and converted

into agriculture land.

Figure 79 Satellite Images showing loss of Bichala lake, Jalatman lake and some more waterbodies

The **diversion of the water canal** disrupted the hydrological connectivity to **Parvat Lake**, ultimately leading to its **drying up and loss**.

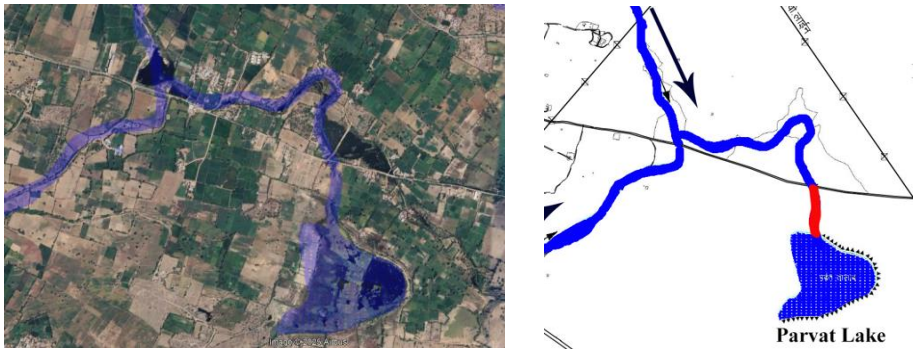

Figure 80 Satellite image showing loss of network to Parvat Lake

Figure 81 Some more site images of canals

Figure 82 Current Condition of the canals

Water quality Assessment of Gundolav Lake

Gundalav Lake is a perennial shallow freshwater body totally rain-fed, man-made lake, situated in the South-west of Kishangarh. It is about 120 hectares (1.2 sq km) in area. Part of historical, cultural, economic, and recreational life of Kishangarh. Its Foundation laid in Vikram Samvat 1527 (1470 AD) by Seth Gunda Shah Agarwal for public benefit. Historically, it is used for drinking water and recreation under Kishangarh princely state.

Key sites around the lake:

- Ram Tekri (north)
- Khoob-Kutir (southeast)
- Yagya-sthali
- Manak Tekri
- Phool Mahal
- Awanna (east, former water outlet)
- Shiv-Ghat (oldest ghat)

- Mokham Vilas (center, scenic view)

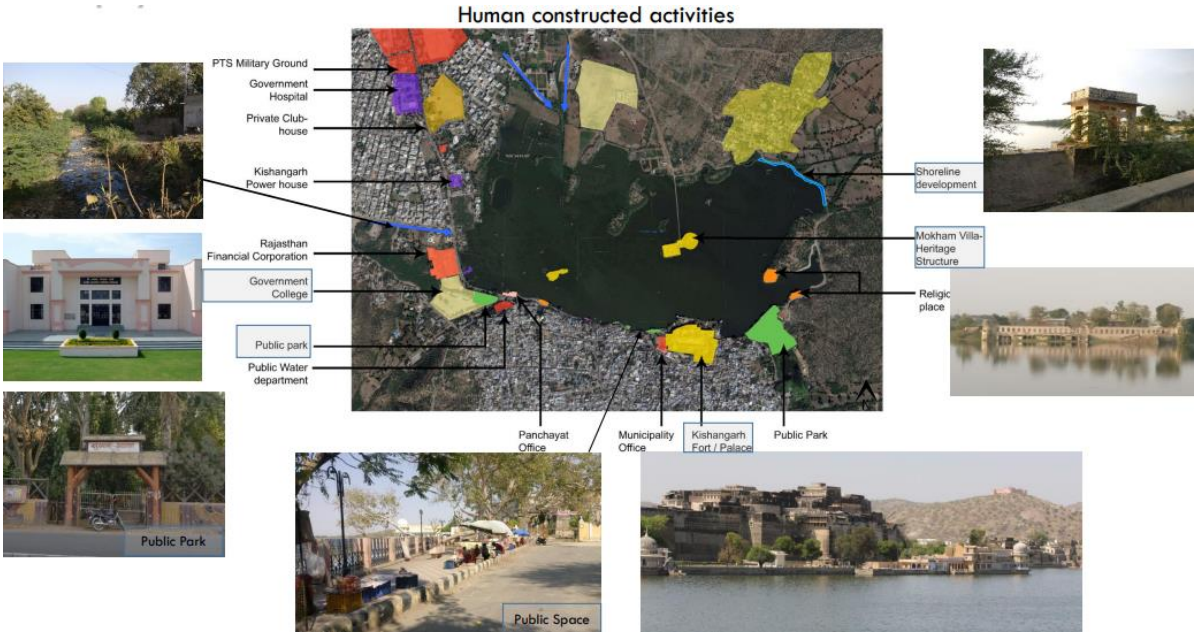

Figure 83 Key sites around Gundolav lake

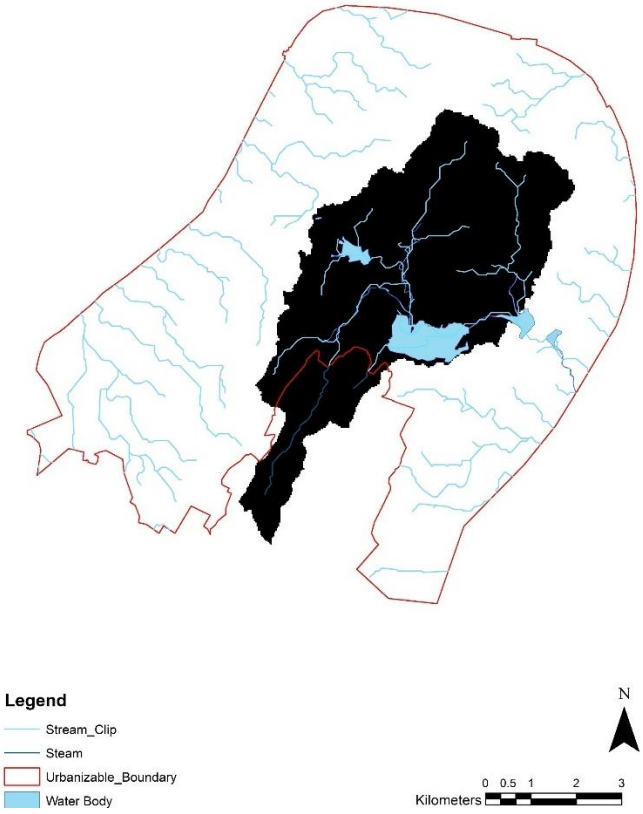

Figure 84 Catchment area of Gundolav lake

For the study five sites are selected: Bheru Ghat (Station I, South), a popular spot for bathing and washing; Shiv Ghat (Station II, South), a deeper area with significant human activity; Temple Corner (Station III, South-East), the least disturbed location; Nala Site (Station IV, West), where untreated domestic sewage is discharged and agricultural/grazing activities occur; and Awanna ki Pal (Station V, East), which is near agricultural fields and some dwellings. (A. Sharma, 2010)

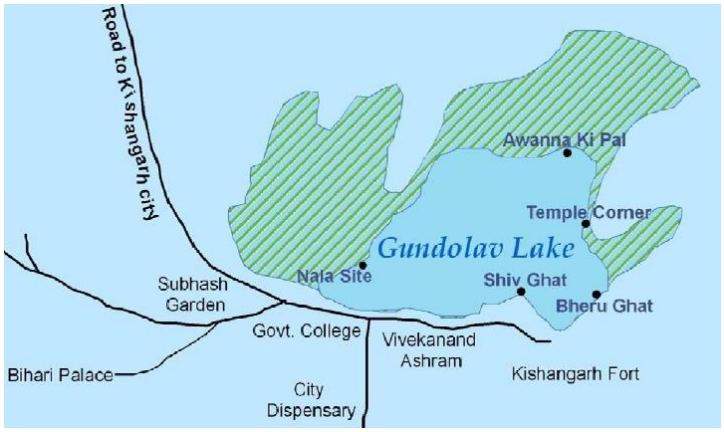

Figure 85 Map of Gundolav Lake showing different study stations and surroundings

Temperature (in ^{0}C)		Station 1	Station 2	Station 3	Station 4	Station 5	Overall
	Average	23.00	22.92	22.58	23.65	23.13	23.06
	Standard Deviation	5.58	5.55	5.46	5.82	5.71	5.61
Transparency (in cm)							
	Average	64.44	62.30	85.60	30.20	64.43	60.96
	Standard Deviation	10.30	9.65	9.43	11.56	9.65	9.78
Turbidity (in NTU)							
	Average	7.55	8.57	7.16	41.05	8.01	14.47
	Standard Deviation	3.58	4.84	3.63	12.33	4.65	5.39
pH (in unit)							
	Average	7.7	9.60	8.44	8.50	8.49	8.49
	Standard Deviation	0.50	0.51	0.52	0.67	0.51	0.51
Total Dissolved Solid (in mg/l)							
	Average	356.25	353.83	335.50	1334.25	352.92	546.55
	Standard Deviation	143.70	144.12	136.33	463.09	150.51	188.81
Dissolved Oxygen (in mg/l)							
	Average	6.27	6.12	6.68	3.68	6.29	5.81
	St. Deviation	1.64	1.59	1.74	2.16	1.65	1.70
Biological Oxygen Demand (in mg/l)							
	Average	18.86	19.23	17.48	48.50	18.56	24.71
	Standard Deviation	13.71	13.53	12.81	49.55	13.45	20.09
Nitrate-Nitrogen (in mg/l)							
	Average	1.13	1.07	0.61	3.06	1.21	1.74
	Standard Deviation	0.57	0.55	0.51	2.45	0.58	0.89
Phosphate (Total) (in mg/l)							
	Average	2.24	2.27	1.76	7.86	2.31	4.23
	Standard Deviation	1.43	1.38	1.22	4.97	1.34	1.72

Figure 86 Water quality parameters, at different stations at Gundolav lake

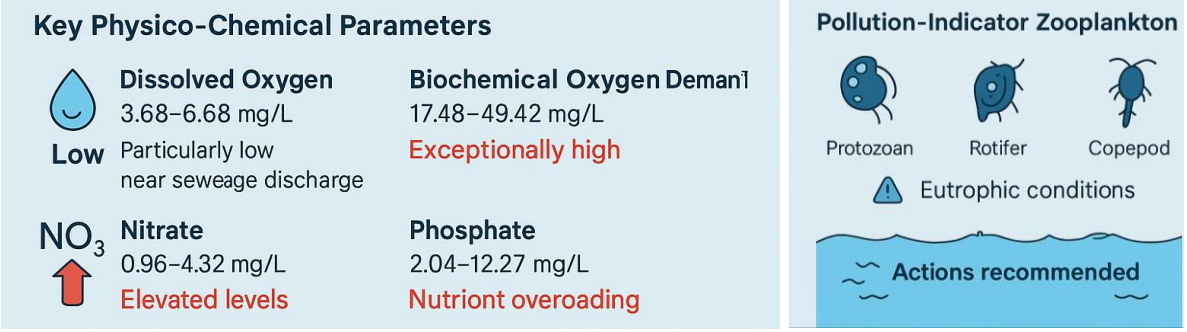

Figure 87 Key physio-chemical parameters and pollution-indicator Zooplankton of the lake

The lake is facing multiple environmental pressures that have significantly impacted its ecological health. One of the major concerns is the **inflow of greywater and untreated sewage**, resulting from the absence of a **centralized drainage system**. Wastewater is directly discharged into the lake, leading to severe water pollution. In addition, **solid waste dumping along the lake banks** has contributed to the deterioration of water quality, posing a threat to **aquatic biodiversity** and degrading surrounding **vegetation**. The problem is further exacerbated by **encroachment**, where **peripheral land reclamation** and **unauthorized constructions** are progressively shrinking the lake area and damaging its **natural catchment zones**.

Despite the **quarterly water quality assessments** conducted by the **Pollution Control Board**, **no significant remedial actions** have been undertaken. Compounding the issue is the lack of **community participation and ownership**, which has resulted in a disconnect between local residents and the lake's management and preservation efforts. These issues collectively highlight the urgent need for integrated lake restoration strategies, involving both institutional action and active public engagement. (Baser, 2023)

Designated Best Use	**Class**	**Criteria**
Drinking Water Source without conventional treatment but after disinfection	A	- Total Coliforms Organism MPN/100ml ≤ 50 - pH: 6.5 to 8.5 - Dissolved Oxygen ≥ 6 mg/l - BOD (5 days @ 20°C) ≤ 2 mg/l
Outdoor bathing (Organised)	B	- Total Coliforms Organism MPN/100ml ≤ 500 - pH: 6.5 to 8.5 - Dissolved Oxygen ≥ 5 mg/l - BOD (5 days @ 20°C) ≤ 3 mg/l

Drinking Water Source after conventional treatment and disinfection	C	- Total Coliforms Organism MPN/100ml ≤ 5000 - pH: 6.0 to 9.0 - Dissolved Oxygen ≥ 4 mg/l - BOD (5 days @ 20°C) ≤ 3 mg/l
Propagation of Wildlife and Fisheries	D	- pH: 6.5 to 8.5 - Dissolved Oxygen ≥ 4 mg/l - Free Ammonia (as N) ≤ 1.2 mg/l
Irrigation, Industrial Cooling, Controlled Waste Disposal	E	- pH: 6.0 to 8.5 - Electrical Conductivity (at 25°C): Max. 2250 µmhos/cm - Sodium Absorption Ratio: Max. 26 - Boron: Max. 2 mg/l
Below-E (Not meeting A, B, C, D, or E criteria)	-	Does not meet any of the criteria listed above

Figure 88 Designated use class and criteria of water according to CPCB

As the water quality of Gundolav lake comes in class C it means that the water can be used for drinking purpose after conventional treatment.

4.6 Sewage System Analysis

Conventionally, wastewater sector has been managed independently. However, it is important to recognize its strong linkages with water and storm water sector. Poor management of sanitation affects both surface water and groundwater quality.

To calculate the sewage generation for Kishangarh, we will use standard urban sewerage design principles based on:

- Per capita sewage generation = 80% of per capita water supply
- Standard water supply rate (as per CPHEEO) = 135 lpcd
- So, Per capita sewage = 108 lpcd
- Total Population of 2025= **190,402**

$$\text{Sewage Generation (MLD)} = \frac{190,402 \times 108}{1,000,000} = 20.5634 \text{ MLD}$$

Estimated Sewage Generation for 2025 = ≈ 20.56 MLD

Estimated Sewage Generation for 2041

Population projected for 2041=2,61,710

Total Sewage Generation (in liters/day)

=2,61,710×108=28,264,680 liters/day

=28,264,680/1,000,000

=**28.26 MLD**

Estimated sewage generation for Kishangarh in 2041 = 28.26 MLD

Currently there is only one STP located on the Nasirabad Highway. It has a total installed treatment capacity of 10 MLD, but currently only 6.5 MLD is being utilized. The method used is Waste Stabilization Pond (WSP), which is a natural and low-cost sewage treatment process relying on the biological activity of algae and bacteria to purify wastewater. (department E. a., 2023)

DETAIL OF EACH EXISTING STPs IN RAJASTHAN STATE					
Sr. No.	**Name of Town**	**Location**	**Existing STP Capacity (MLD)**	**Capacity being utilized (MLD)**	**Treatment Process**
75	Kishangarh	Nasirabad Highway	10.00	6.50	**WSP**

Figure 89 Detail of Existing capacity in Kishangarh

Untreated Sewage=Total Sewage Generation−Sewage Treated

=28.26−6.50=21.76 MLD

Also, the sewer lines only cover the city core and nearby areas. **Untreated sewage** flows into **open drains** and **water bodies** like Hameer Sagar, Gundolav Lake.

No of Sewage treatment plant required in the city to cater the future demand, we need **2 STPs of 10 MLD and 1 STP of 5 MLD**

STP Capacity	Technology (WSP)	Land Required (approx.)
5 MLD	Waste Stabilization Pond (WSP)	3.5 – 4.0 hectares
10 MLD	Waste Stabilization Pond (WSP)	6.5 – 8.0 hectares

Table 13 Area requirement for STP

Total Land Required (WSP-based Estimate):

2 × 10 MLD STPs = 2 × 7.0 ha = 14.0 ha

1 × 5 MLD STP = 1 × 3.8 ha = 3.8 ha

= 14+3.8 ha

=17.8 ha

If newer compact technologies like **SBR** are used:

- **Land requirement may reduce by 60–70%**
- Total area = **5.5 – 7.0 hectares** (approx.)

4.7 Socio-Economic Assessment

Public survey conducted from which major findings are:

Lack of safe drinking water as the local government is unable to provide water because the city receives water from the municipality once in two days only for 2 to 4 hours leading to dependence of the city majorly on ground water. The stage of groundwater development exceeding 100% signifies unsustainable extraction rates also the ground water is not safe for drinking and agricultural use. There is high public awareness of water-related problems and Mining and industrial activity seen as primary contributors

Surveys also showed high concern about **health issues, water availability**, and **pollution**. Many respondents reported **dental/skeletal fluorosis**, and **respiratory and skin diseases**. Index scores for perception of groundwater-related risks were high (up to 4.25 on a scale of 5).

Chapter-5

Proposal

Holistic Approach to Conserve Surface Water Bodies in Kishangarh

Kishangarh's historically interconnected lake and canal system—comprising **Gundolav Talav, Hameer Sagar, Ransamand Talav, Satolav**, and other smaller ponds—once ensured natural water circulation, stormwater regulation, and groundwater recharge. However, in recent decades, **pollution, encroachments, and urban neglect** have threatened the ecological and cultural integrity of these water bodies.

To rejuvenate these assets, a **multi-dimensional, integrated conservation strategy** is required.

4.1 Restoration of canal network

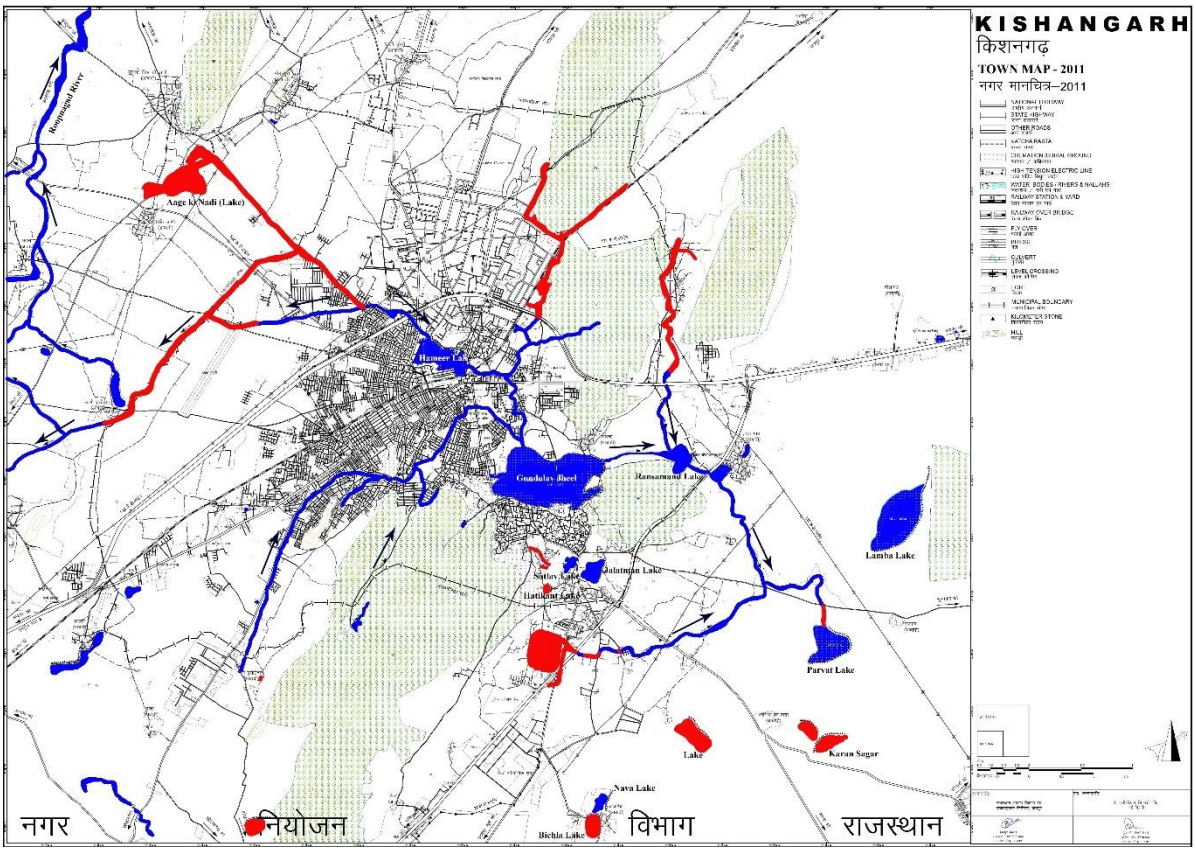

Figure 90 Proposed restoration of canals

4.2 Water treatment plant

As the water of Gundolav lake comes in the category of Drinking water source after conventional water treatment so a water treatment plant is proposed near Gundolav lake.

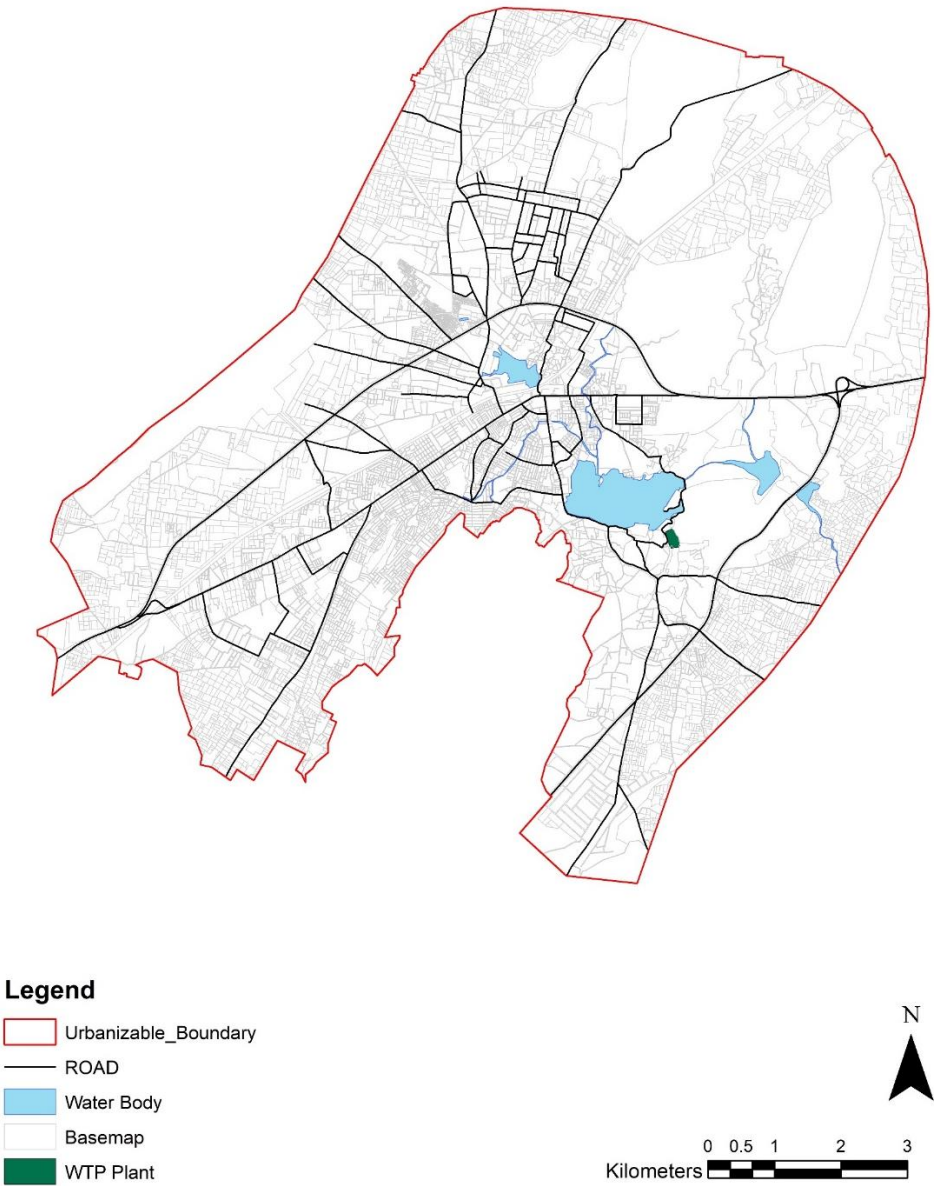

Figure 91 Proposed location of Water treatment Plant

4.3 Recommendations for Revival of Gundolav lake

Following are some of the measures if implemented in letter and spirit, can be useful for long term sustainability of this lake.

1. To control eutrophication, regular monitoring of water, preparation of an inventory of source-wise contribution of nutrients inflow and then applying methods to reduce nutrient supply at source and removal of locked up nutrients should be done.
2. Farmers particularly cultivating in catchment area should be motivated to adopt natural

and organic farming techniques instead of heavy dependence on chemical based farming. Use of chemical fertilisers, pesticides, herbicides and insecticides should be prohibited.

3. Training to the municipal officials and sanitary workers should be given on regular basis on door to door segregated waste and techniques of collection to build their capacity. They should be trained in various green methods of waste segregation and management so that liquid and solid waste generated by the city does not pollute lake water.
4. Municipal sewage should be treated by different mechanical, biological and green chemical methods to remove BOD, phosphorus, nitrogen, solids and harmful bacteria before discharge.
5. People living near lake or in the catchment area should be environmentally sensitised so that they do not throw solid waste into natural drains.
6. During dry season, when the water level of this lake is at low, macrophytes and fishes can be removed (Sharma et. Al, 2010). This will help in removal of locked up nutrients in lake water.
7. Dredging of sediments out of the lake should be done with the involvement of community. It will not only remove a large quantity of nutrients but also lead to deepening of lake and hence storage capacity of lake is also improves.
8. Lining of the feeder from Hameer Sagar to Gundolav Lake should be done to reduce the problem of siltation.
9. Afforestation should be done in catchment area.
10. General environmental awareness programmes to sensitise people feeding food to fishes and birds, bathing, washing clothes and throwing waste in the lake should be launched.
11. Construction activities in the catchment area should be banned and the existing encroachments should be removed.
12. Local traditional water harvesting knowledge should be incorporated with advance modern technology for conservation and restoration of this historical lake.
13. For proper and sustainable management of the lake, public private partnership and

active involvement of community is necessary for successful abatement of pollution in this lake.

14. To boost local economy and generate employment opportunities by promoting tourism and recreational activities, beautification of this lake should be done.

4.4 Buffer zones from industrial area

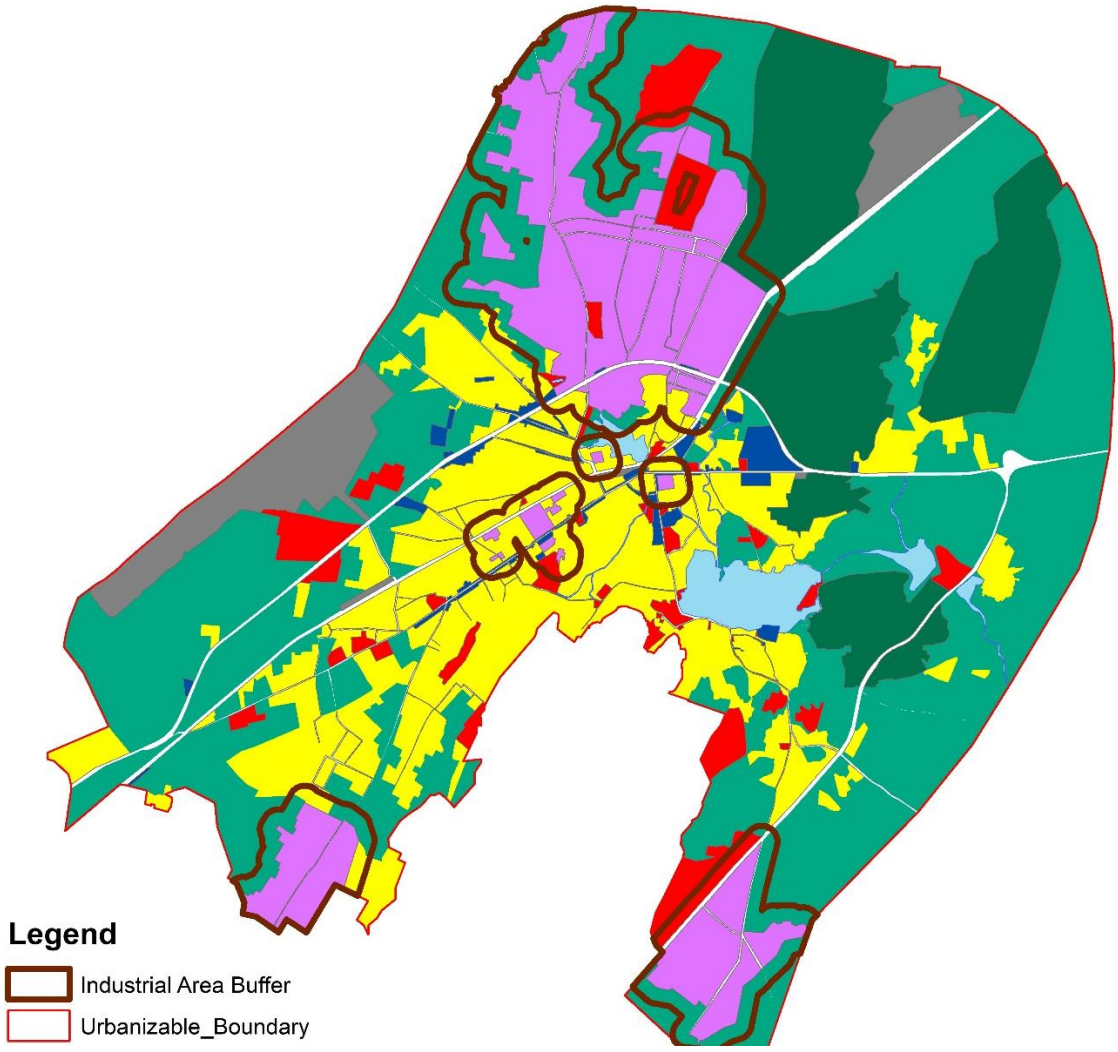

Figure 92 Buffer Zones from industrial area

4.5 Green buffer for water bodies to protect its catchment

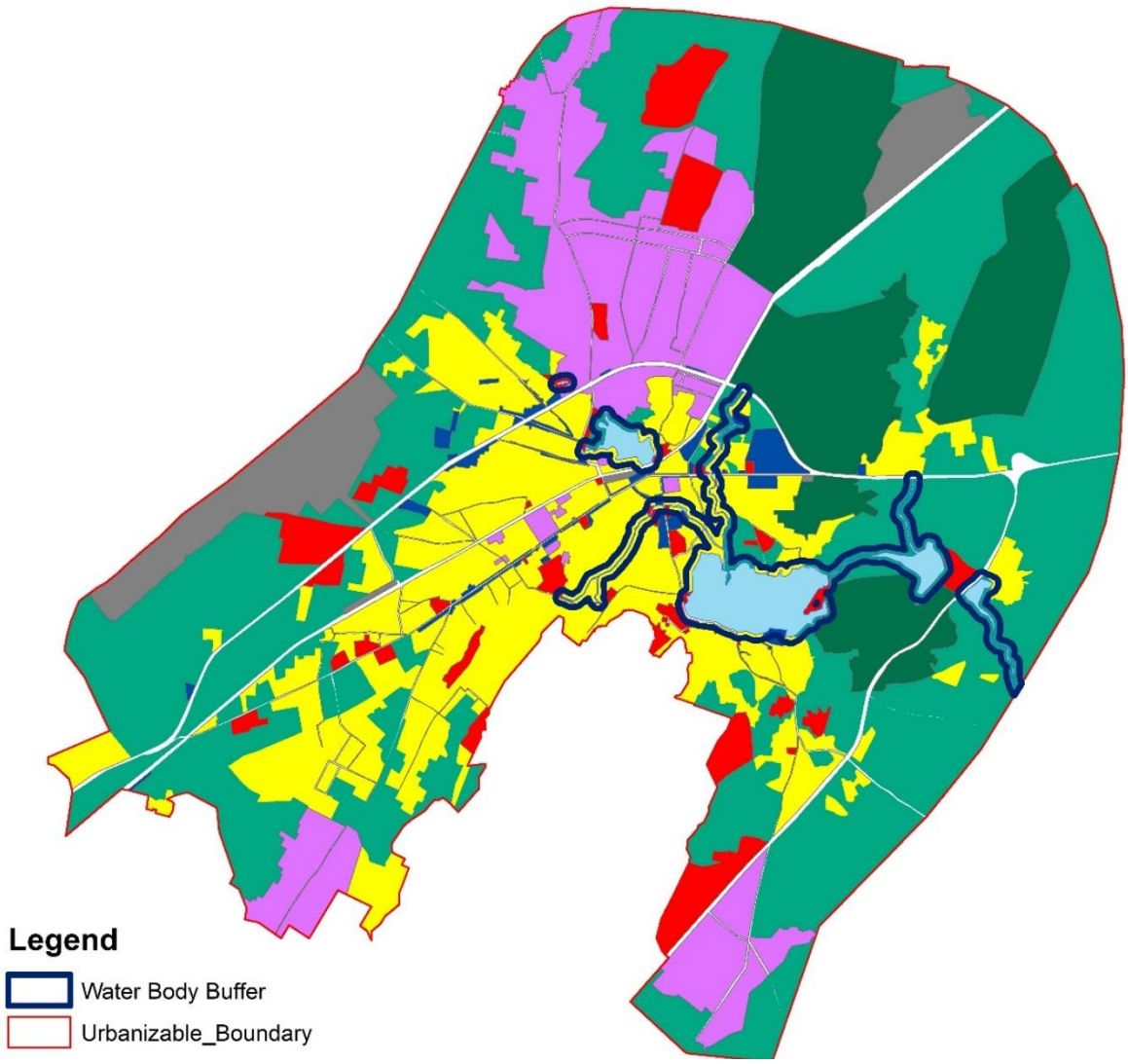

Figure 93 Buffer Zones from Waterbodies

4.6 Guidelines for marble slurry dumping site

1. Location should be 1km away from habitation and water bodies, and can be within existing processing premises or at isolated locations with proper approach roads
2. Dumping sites should not be located on 100-year flood plains to prevent flow restriction and potential contamination during floods Scientific development after Environmental Impact Assessment is recommended.
3. Design for at least 15 years with compacted clay lining and water decanting systems.
4. Development of a 10-meter-thick green belt around dumping sites.

5. Regular inspection, maintenance, and measures to prevent fugitive emissions.
6. Establishment of an escrow fund for operation, maintenance, closure, and post-monitoring.
7. Daily record-keeping of slurry received and lifted.

Guideline for Design and Construction Marble Slurry Dumping Sites:

Must be designed, constructed, operated, and maintained for a minimum of 15 years.

The base and sides must have a compacted clay lining at least 1 meter thick with a low hydraulic conductivity (K ≤ 1x 10-7 m/s) to prevent seepage into the ground.

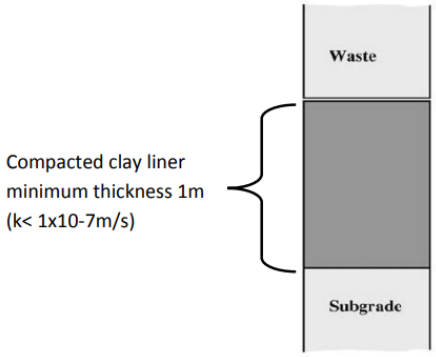

Figure 94 Suggested liner system for marble slurry dumping site

Should include a proper water decanting system, such as a decanting well or a network of perforated PVC pipes at the bottom, to collect the water from the slurry.

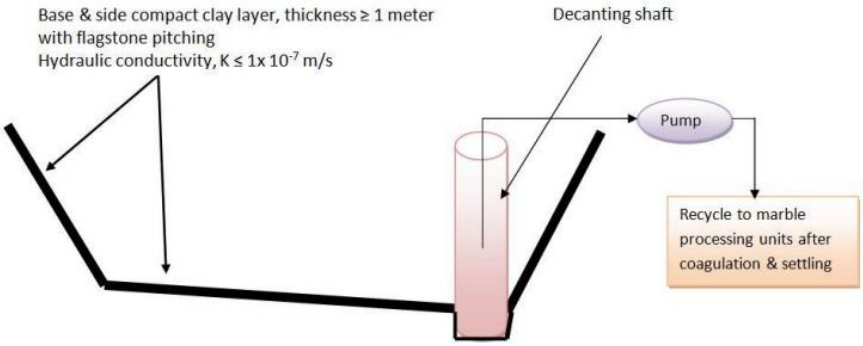
Base & side compact clay layer, thickness ≥ 1 meter
with flagstone pitching
Hydraulic conductivity, K ≤ 1x 10-7 m/s
Decanting shaft
Pump
Recycle to marble
processing units after
coagulation & settling

Figure 95 Cross sectional design for marble slurry dumping site

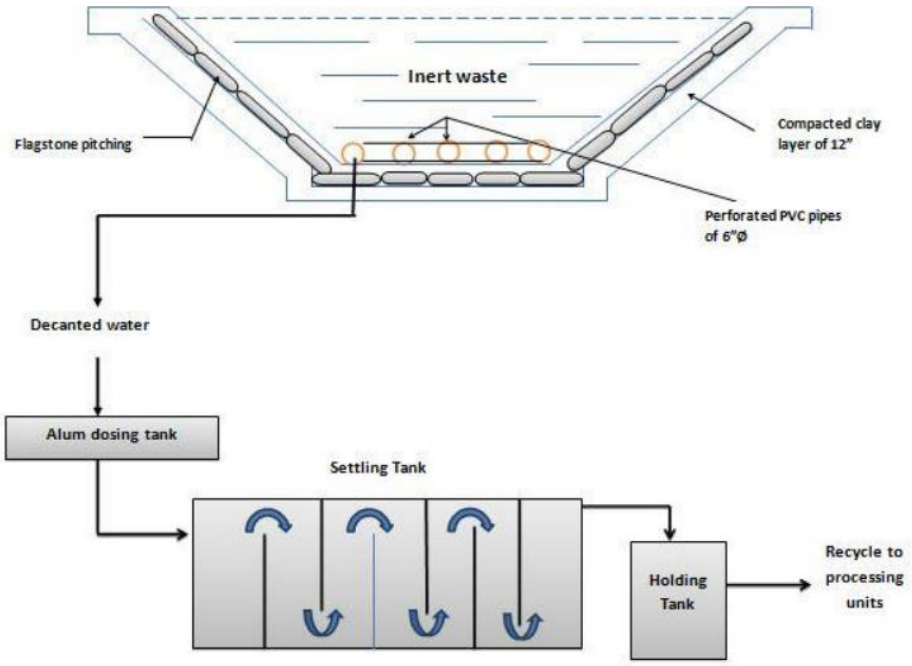

Figure 96 Marble slurry dumping site and water recycling system design

Marble slurry dumping site and water recycling system design

Green Belt Development: A 10-meter-thick green belt consisting of wide-leaf plant species must be established around the perimeter of the dumping site to trap airborne fine particles and mitigate air pollution.

Operation and Maintenance:

Regular monthly inspections are mandatory during the operational phase and for at least 5 years post-closure. These inspections are part of the maintenance and contingency plan.

Measures should be taken to prevent wind erosion and fugitive emissions from dried marble slurry.

Escrow Fund: To ensure proper operation, maintenance (including closure and post-monitoring), an escrow fund needs to be created. Contributions to this fund will come from all members of marble associations and RIICO (Rajasthan State Industrial Infrastructure Development Agency). The fund will be managed by a private limited company comprising representatives from local marble associations, district administration, RIICO, and the SPCB (State Pollution Control Board). The contribution amounts will be decided in a general body meeting of this company.

Temporary Closing System: The waste stored in these sites should eventually be utilized for beneficial purposes

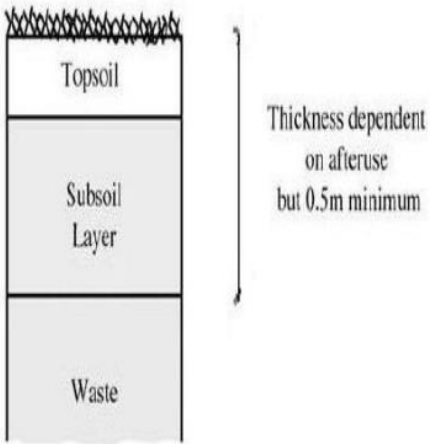

Figure 97 System for closure of dumping site

Proposal for Beneficial Uses of Marble Slurry: Encourage utilization as:

Ordinary Portland Cement (OPC) Manufacturing:

Utilize 10-12% marble slurry as a raw mix component and/or additive, following recommendations from NCBM (National Council for Cement & Building materials). Moisture content needs to be adjusted.

Replace 3-5% of OPC clinker with marble slurry during grinding as a performance enhancer, adhering to moisture requirements and Indian Standards (IS: 8112:1989).

Nearby marble associations should collaborate with cement industries, establishing mutual agreements for business conditions, including a 50% shared transportation cost (rates to be decided in consultation with SPCB/PCC).

1. Road Construction: Replace 20-35% of in-situ soil with marble slurry in the sub-grade layer, following specifications of PWD (Public Work Department) and NHAI (National Highway Authority of India). Reference is made to research by the Central Road Research Institute.
2. Binder in Non-Load Bearing Structures: Utilize marble slurry as a low-cost binder with a sand ratio of 1:3, as per IS: 3466-1988 and PWD specifications. Reference is made to technical work by Shri Sampat Lal Surana.
3. Filler Material in Mineral Grinding: Mineral grinding units (feldspar, soda & quartz) should aim to use 15-20% marble slurry as a filler, adhering to mineral specifications.

4. Thermal Power Plants and Zinc Smelters: Coal/pet coke-based thermal power plants are encouraged to explore using marble slurry for desulphurization and gypsum production. Zinc smelters can investigate its use with Jarosite waste for synthetic gypsum production
5. Iron & Steel Industry: Explores the potential use of marble slurry as a flux or reducer based on its SiO2 content and loss on ignition.
6. Calcium Nitrate Fertilizer Production: Entrepreneurs interested in manufacturing Calcium Nitrate fertilizer from marble slurry can approach the concerned SPCB/PCC for necessary consents, which will be considered on a priority basis. The chemical reaction for this process is provided.
7. Artifacts, Chips, Tiles, and Brick Manufacturing: A significant quantity of marble and its slurry should be used in the production of artifacts, chips, and tiles, as well as in brick manufacturing (approved by PWD as per specific guidelines dated 01-05-1998).

Figure 98 Marble Slurry used in brick artifacts and tiles manufacturing

References

A. Chowdhury, A. B. (1978). *Meteorological aspects of arid and semi arid regions of India with special reference to Thar desert.* Pune.

A. Sharma, R. M. (2010). *Water Quality Status of Historical Gundolav Lake at.* South Asian Journal of Tourism and Heritage.

Academy, N. W. (n.d.). *India Water Portal*. Retrieved from Traditional Water Conservation in India : https://hindi.indiawaterportal.org/articles/traditional-water-conservation-india-bhaarata-maen-paaranparaika-jala-sanrakasana

Aklan, M., Fraiture, C. d., Hayde, L. G., & Moharam, M. (2022). Why indigenous water systems are declining and how to revive them: A rough set analysis. *Journal of Arid Environment*. Retrieved from ScienceDirect.

Amit Wahurwagh, A. D. (2015). Burhanpur Cultural Landscape Conservation: Inspiring Quality for Sustainable Regeneration. *MDPI*.

Baser, R. K. (2023). *Assessment of Physicochemical.* Ajmer: International Journal Of Multidisciplinary Research In Science, Engineering and Technology (IJMRSET).

Bhatia, B. (2024, Feb 26). *FLOTTA*. Retrieved from 5 Traditional Methods of Water Conservation You Can Use Today: https://flotaa.com/traditional-methods-of-water-conservation/

Bhawan, N. I. (2000). *Status report on Hydrology of Arid Zones of India.* Roorkee.

BOARD, C. G. (2017). *Aquifer mapping and ground water.* JAIPUR: MINISTRY OF WATER RESOURCES, RIVER DEVELOPMENT & GANGA REJUVENATION.

Board, C. G. (217). *AQUIFER MAPPING AND MANAGEMENT.* Jaipur.

board, C. p. (2019). *"Indicative Guidelines.* Delhi: Ministry of Environment, Forest and Climate Change, Govt. of India).

Board, C. P. (n.d.). *Guidelines for Management and Handling of Marble Slurry generated from Marble Processing Plants in Rajasthan.* Bhopal: Ministry of Environment & Forests.

Board, C. P. (January 2025). *Classification of Sectors into Red, Orange,Green, White and Blue Categories* . Delhi.

Britannica, T. E. (n.d.). *Britannica*. Retrieved from Bhuj: https://www.britannica.com/place/Bhuj

Centre for Education and documentation. (n.d.). Retrieved from Arid booklet: https://www.ced.org.in/docs/inecc/arid_booklet/Arid-3-Arids.pdf

change, M. o. (n.d.). *Department of Environment,* . Retrieved from Government of Madhya pradesh: http://www.climatechange.mp.gov.in/sites/default/files/ongoing-projects/Burhanpur%20CCAP%20Brochure-En.pdf

department, E. a. (2023). *Six Monthly Compliance Report in O.A. no. 606/2018.* Jaipur: Government of Rajasthan.

department, T. P. (n.d.). *Kishangarh Masterplan (2011-2031).* Kishangarh.

Gaurav Sharma, C. K. (2020). *Assessment of Meteorological Drought characteristics using Standardized.* Varanasi: Department of Farm Engineering, Institute of Agricultural Sciences, Banaras Hindu.

Gour, A. A. (n.d.). Revisiting Kundi Bhandara: Understanding theAncient Water Management Systems from theMughal Period - Case of Burhanpur City,. *International Journal for Multidisciplinary Research* .

ICLEI – Local Governments for Sustainability, S. A. (2017). *Integrated Urban Water Management Planning and Implementation in Kishangarh, Rajasthan.* Gurgaon: India Water Partnership (IWP).

India, G. o. (2015). *Urban and regional development plans Formulation and implementation (URDPFI) Guidelines* . Town and Country Planning Organisation.

Journey, M. H.-A. (2022). Retrieved from https://maharajaholiday.com/kishangarh.php

Kalsi, R. (2007). *Status, Distribution and Management of Galliformes in Arid and Semi-arid Zones of India. In: Sathyakumar, S. and K. Sivakumar (eds.). Galliformes of India. ENVIS Bulletin: Wildlife and Protected Areas, Vol. 10 (1). Wildlife Institute of India, Dehradun, I.* Dehradun.

Meghalaya, G. o. (2022, November 21). *Public Health Engineering Department, Government of Meghalaya.* Retrieved from National Informatics Centre, Meghalaya State Centre: https://megphed.gov.in/rainwater/Chap2.pdf

Mishra, M. C. (2021, December 23). *Mongabay*. Retrieved from Reviving 400-year-old Mughal era water structures to combat climate change in MP's Burhanpur: https://india.mongabay.com/2021/12/reviving-400-year-old-mughal-era-water-structures-to-combat-climate-change-in-mps-burhanpur/

RajRAS by connect civil. (n.d.). Retrieved from Traditional Methods of Rain Water Harvesting in Rajasthan: https://rajras.in/traditional-methods-rain-water-harvesting-rajasthan/

Rathore, D. M. (2007). *Sustainable, Safe Drinking Water.* Alwar : Tarun Bharat Sangh.

Reddy, M. (n.d.). Indian Arid Zone (With Diagram) . *Biology Discussion*.

Sakshi Patel, D. R. (2024). *Assessment of Local Level Heritage Value of Kishangarh,.* Gujrat: School of Interior Design, UID, Karnavati University.

sangh, t. b. (2016). *theflowpartnership*. Retrieved from tarun bharat sangh: https://www.theflowpartnership.org/tarun-bharat-sangh

shakti, M. o. (2022, March 14). *Ministry of Jal shakti*. Retrieved from Renovation of Traditional Water Bodies: https://pib.gov.in/PressReleaseIframePage.aspx?PRID=1805822

Sheth, D., & Iyer, M. (2021, March 17). Local water resource management through stakeholder participation: case study, arid region, India . *Water Practice and Technology (2021) 16 (2)*, pp. 333–343.

(2017). *Urban Water Security Toolkit* .

Wipperman, A. (2020, December 22). *How ancient water conservation methods are reviving in India*. Retrieved from Global centre on Adaptation: https://gca.org/how-ancient-water-conservation-methods-are-reviving-in-india/